PM010 – 19 December 2023
Update on PINNs

Application to Urban Wind Field Dispersion Studies

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Script Version v4

1) PINN is now completely customizable – customizable input and output parameters, batch normalization, dropout rate, neuron number, number of hidden layers – all options in the config file (PM007)
2) Saving of all the losses (not just the total loss) (PM007)
3) Plotting of loss vs epochs now automatic (PM007)
4) Boundary conditions – relaxed no slip condition included (PM007)
5) New angles included (PM007)
6) Smaller batch sizes (I disagree) – customizable from config file (PM007)
7) Testing and Predicting Loss during training phase (PM008)
8) Inlet Boundary Conditions added (PM008)
9) Inlet Boundary for the Z-direction made to follow a log equation (PM009)
10) Debugged for no slip loss BC (PM009)
11) Activation function updated to an exponential linear unit instead of ReLu {arXiV: 1511.07289} (PM0010)
12) Script is being modified for TPU use (PyTorch → Tensorflow) (PM010)

Scripts v4 – Preliminary Results

Some Parameters

Infinite epochs - instead the criteria for stopping is loss_{n} - loss_{n-1} < ε for 10 consecutive epochs where n is the epoch number and ε = 1E-5 (user defined)

128 Neurons for the PINN unless otherwise specified

We have the data for 13 angles, [0, 15, 30, 45, 60, 75, 90, 105, 120, 135 150, 165, 180] in degrees

We concatenate the data for angles = [0, 15, 30, 45, 60, 75, 90, 105, 120, 150, 165, 180] and then take 99% of the dataset with random seed = 42 for training and 1% for testing

By using 99% of the whole dataset we hope to make the NN learn about wind angle such that the parameters become functions of the wind angle

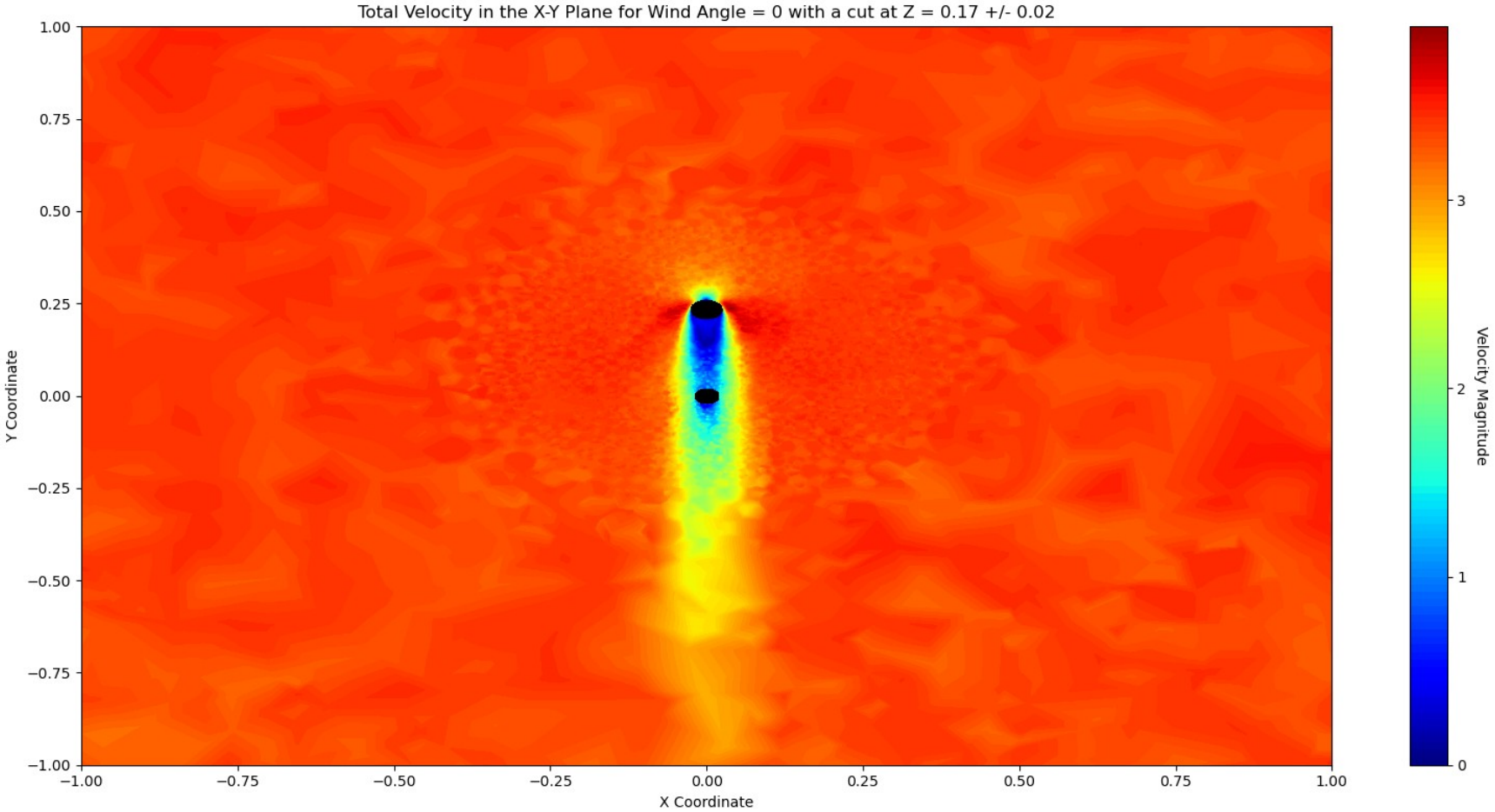
Then using the trained neural network we predict the data for angle = 135

For this run, we will only have input parameters to be [X, Y, Z, cos(\theta), sin(\theta)] and the output parameters will be [U, V, W]

Progress so far - Data Loss Only Standard Normal Scalar (Adam Optimizer)

Threshold = 1E-5 (23375 Epochs, not completed), GPU Laptop

Scripts v4 – Plotting Any Angle


Total Velocity in the X-Y Plane for Wind Angle = 0 with a cut at Z = 0.17 +/- 0.02
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X Coordinate
Velocity Magnitude
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0.00
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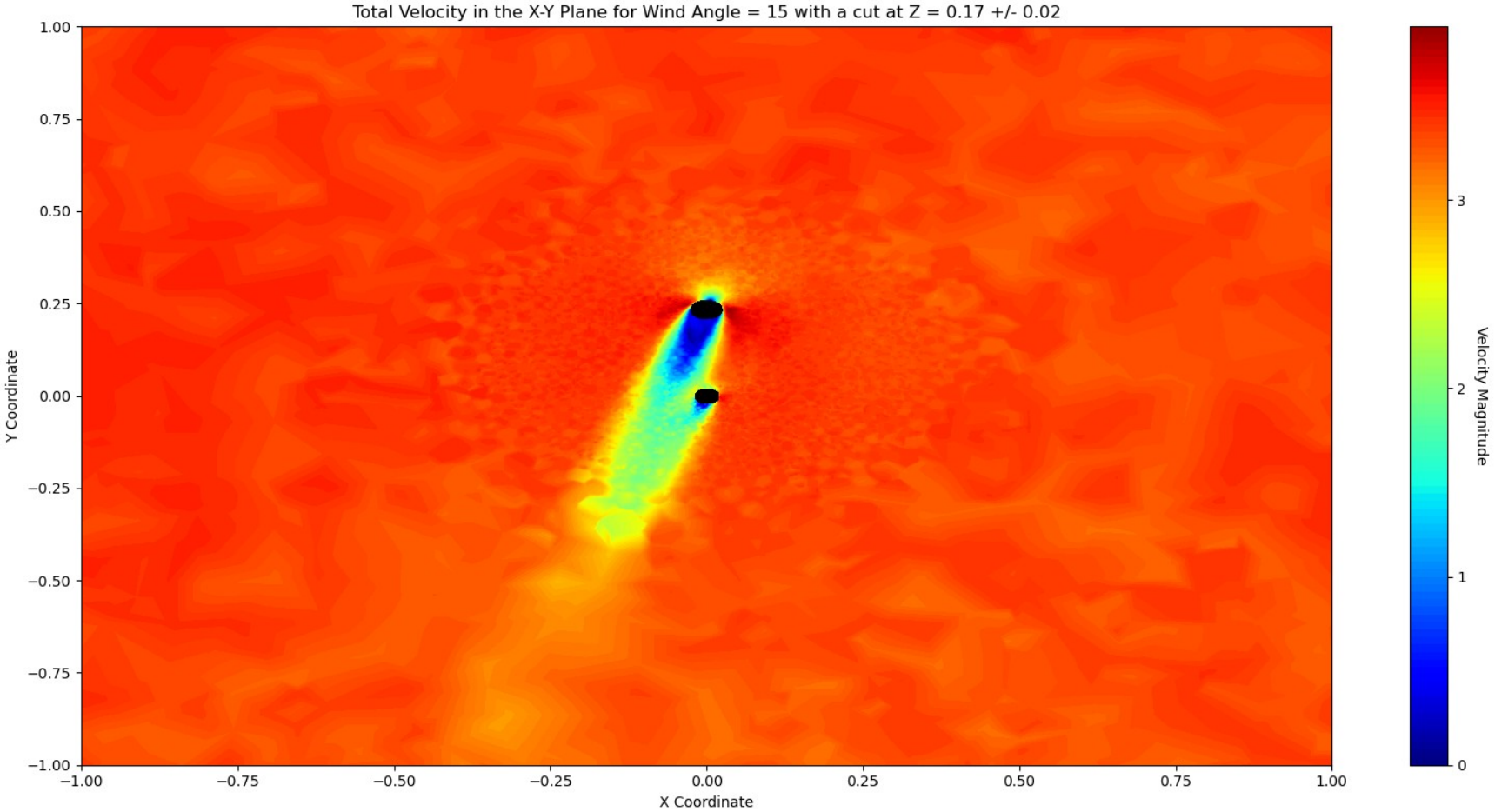
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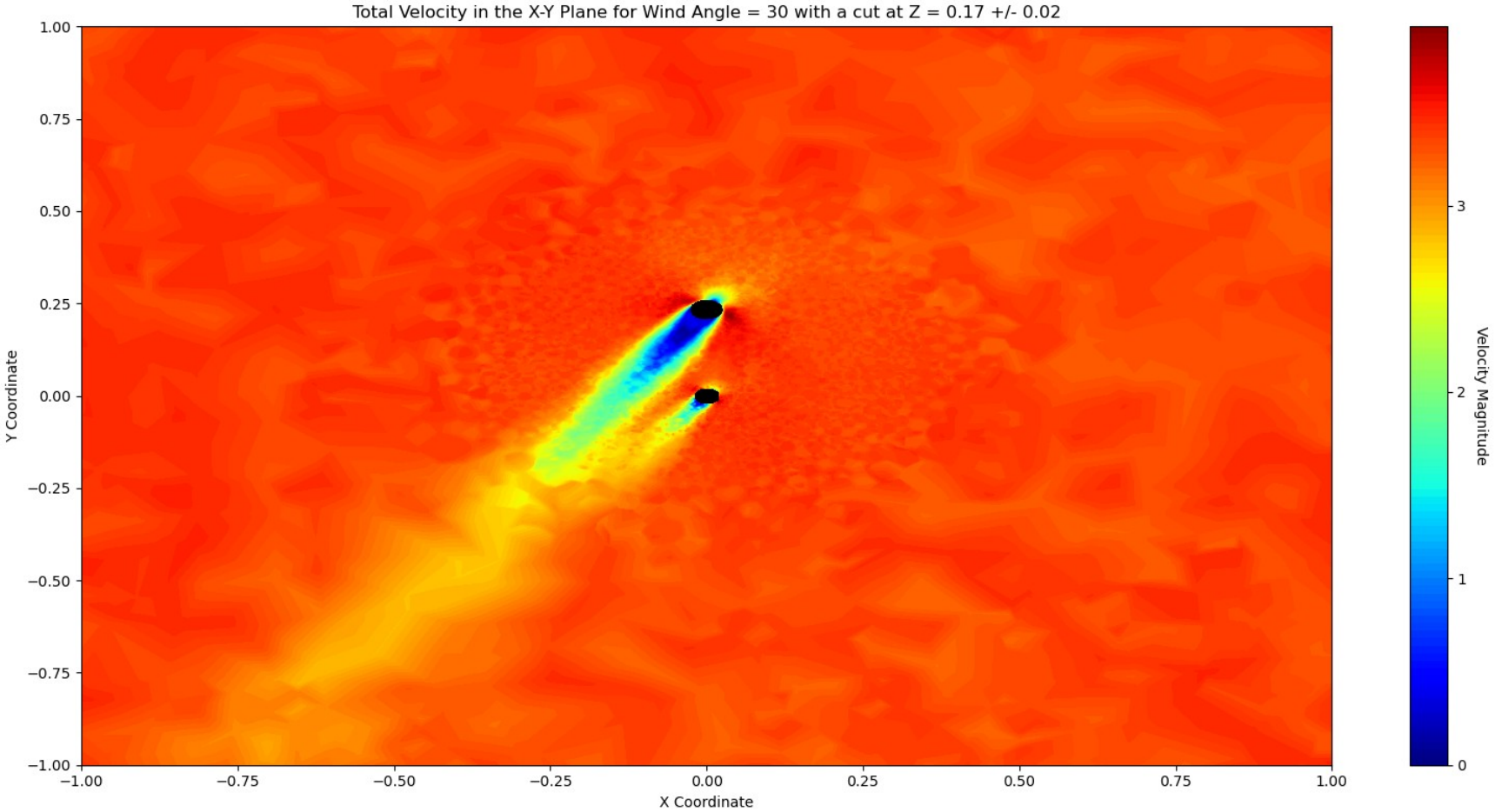
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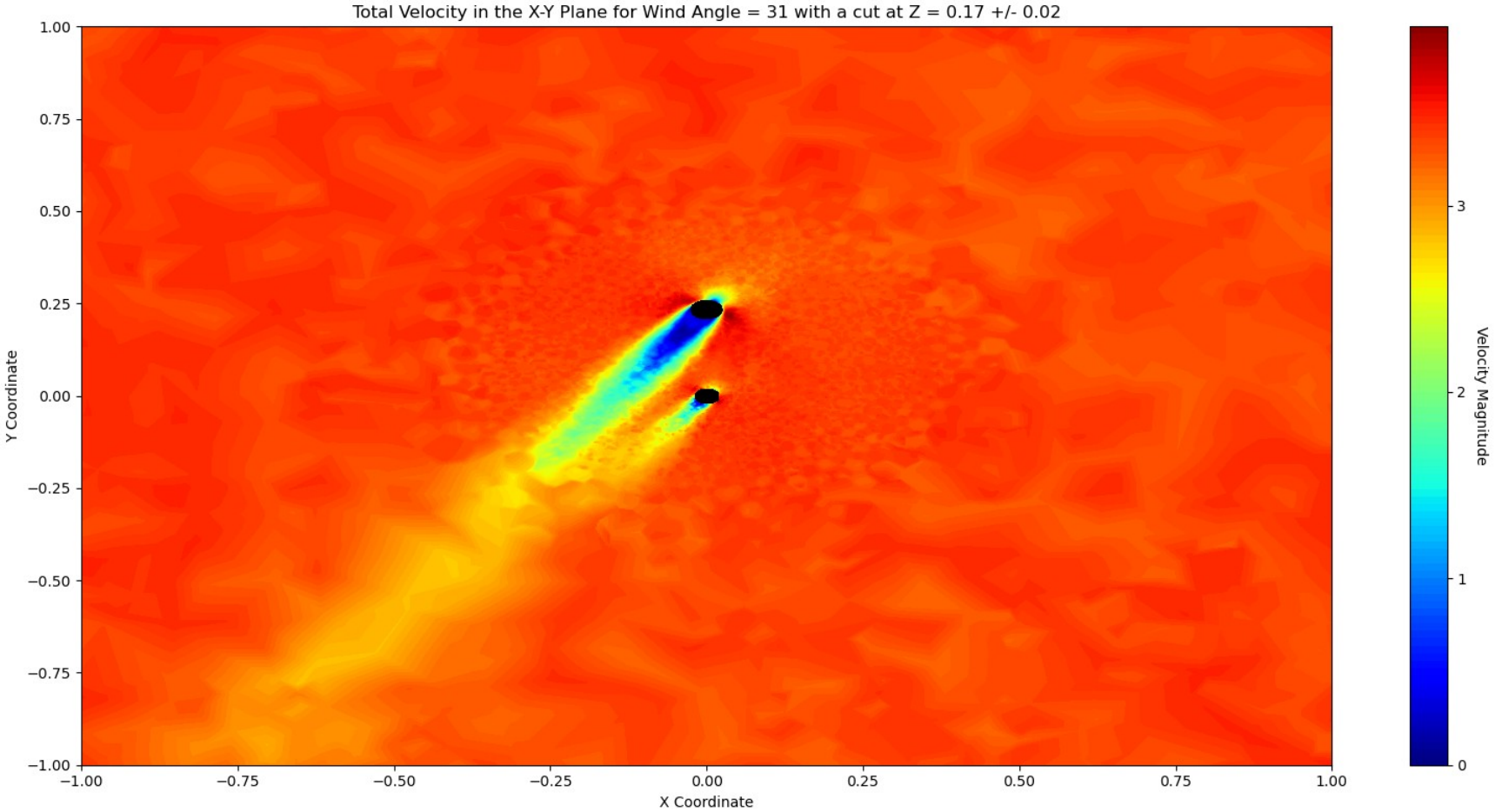
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X Coordinate
Velocity Magnitude
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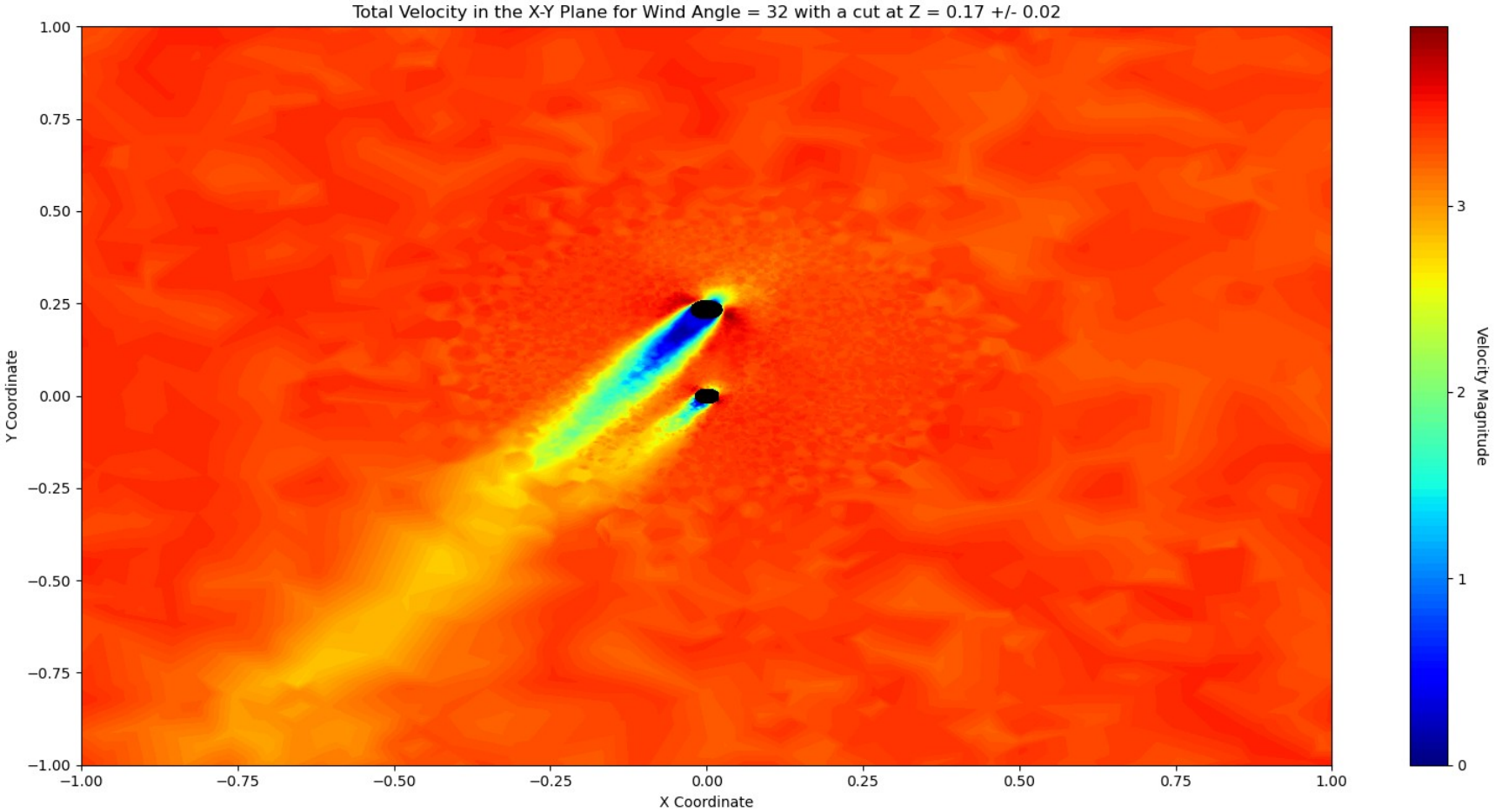
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X Coordinate
Velocity Magnitude
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0.00
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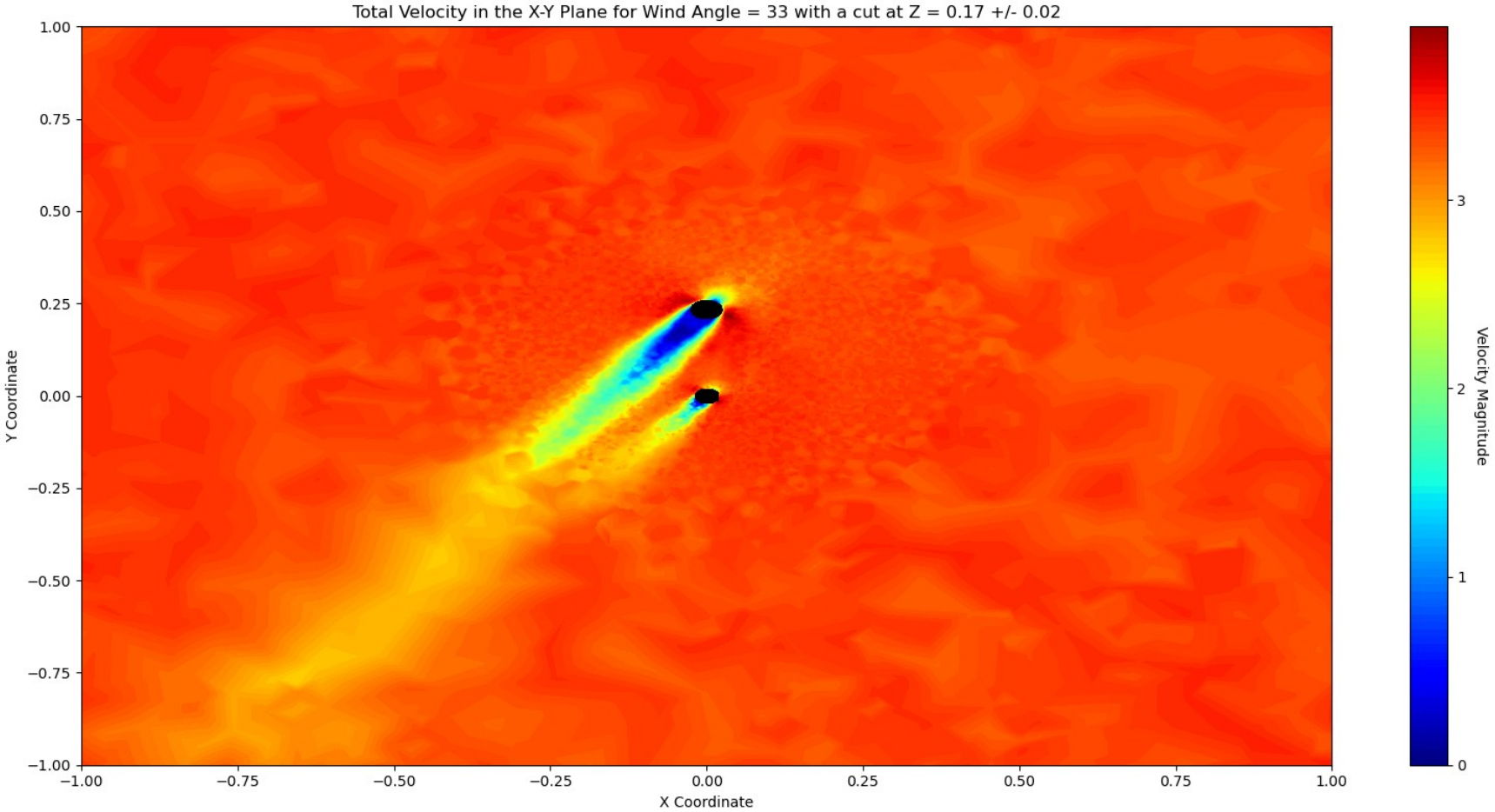
Total Velocity in the X-Y Plane for Wind Angle = 33 with a cut at Z = 0.17 +/- 0.02
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X Coordinate
Velocity Magnitude
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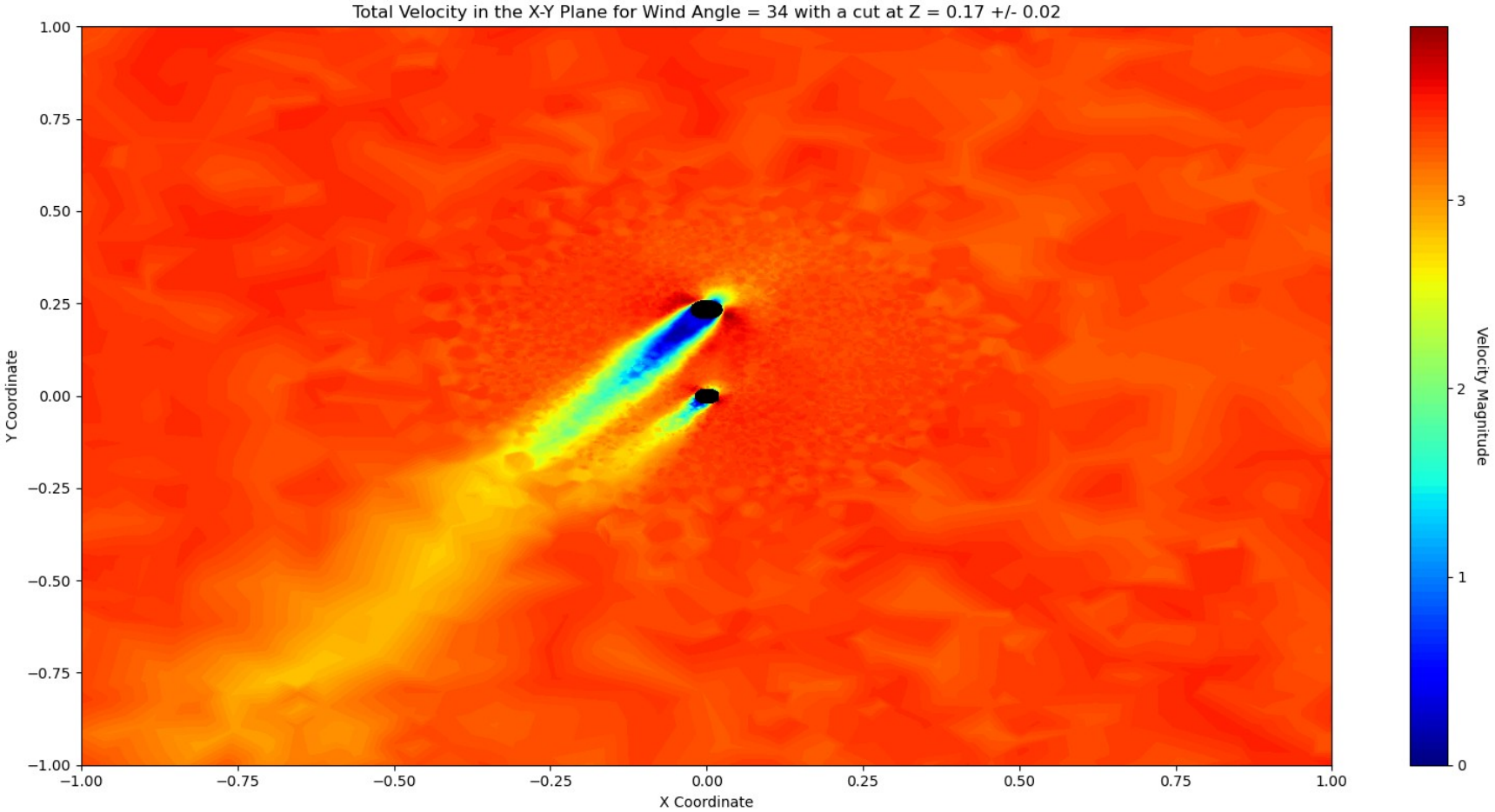
Total Velocity in the X-Y Plane for Wind Angle = 34 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
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0.00
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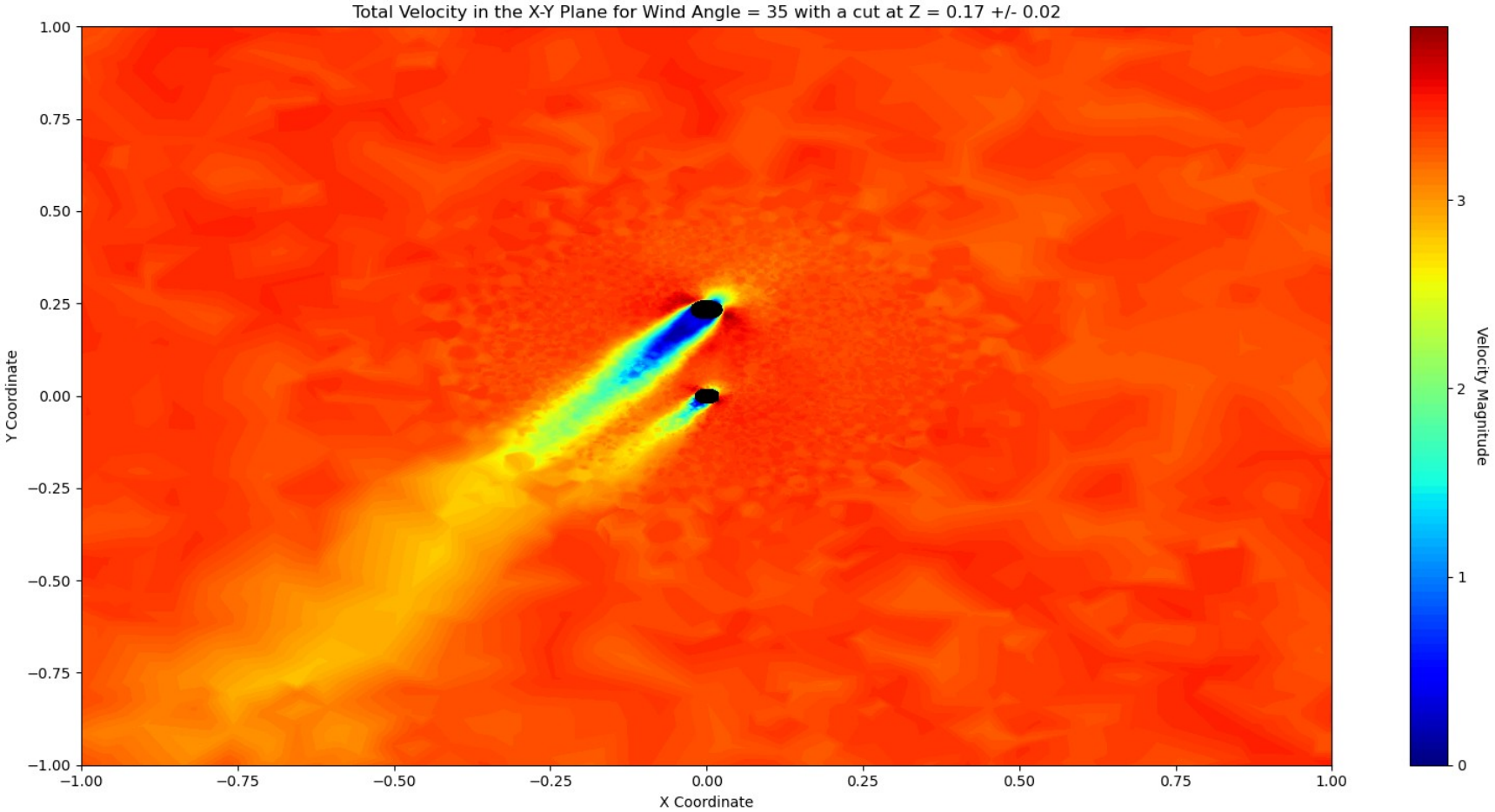
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X Coordinate
Velocity Magnitude
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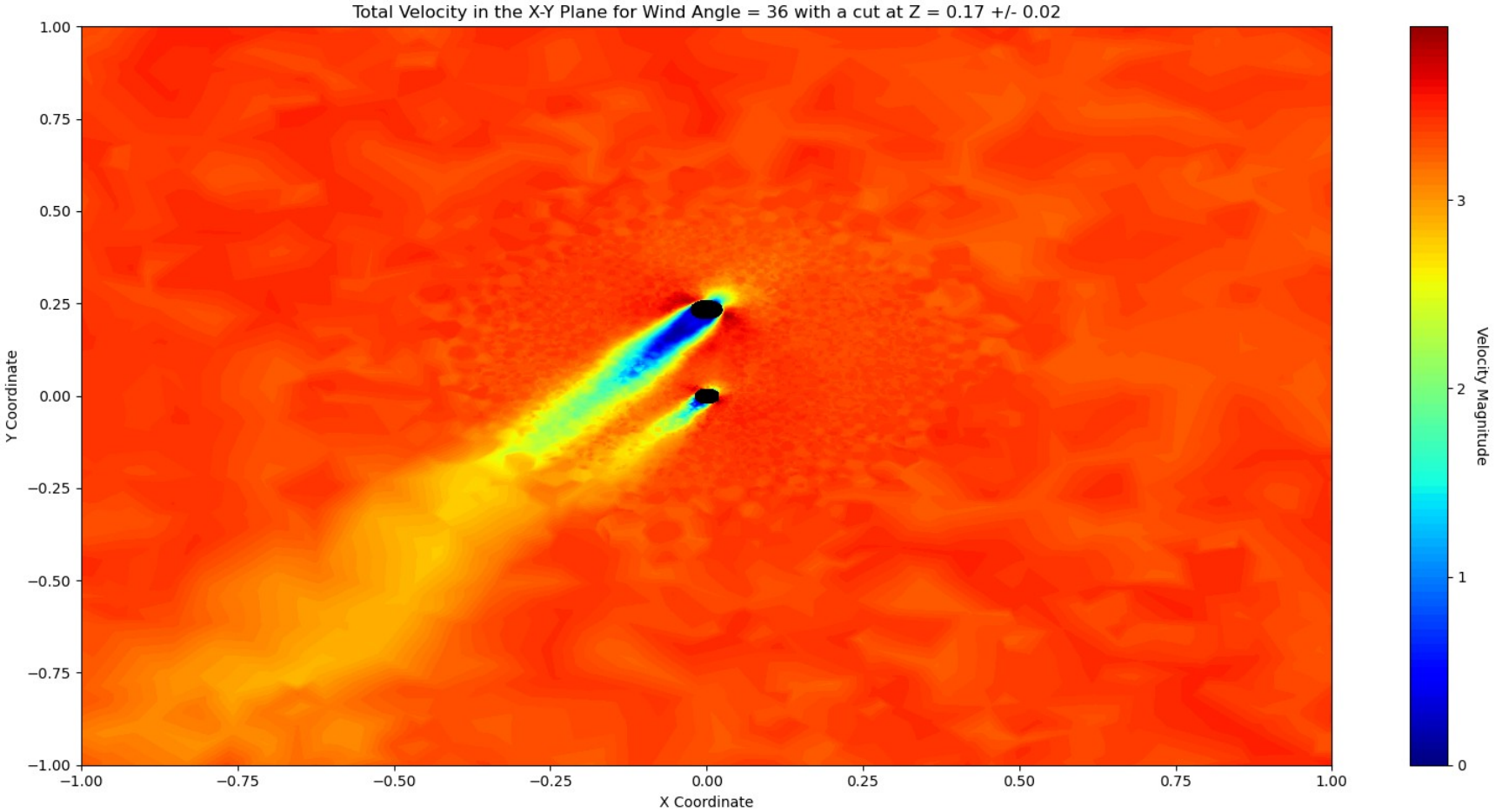
Total Velocity in the X-Y Plane for Wind Angle = 36 with a cut at Z = 0.17 +/- 0.02
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X Coordinate
Velocity Magnitude
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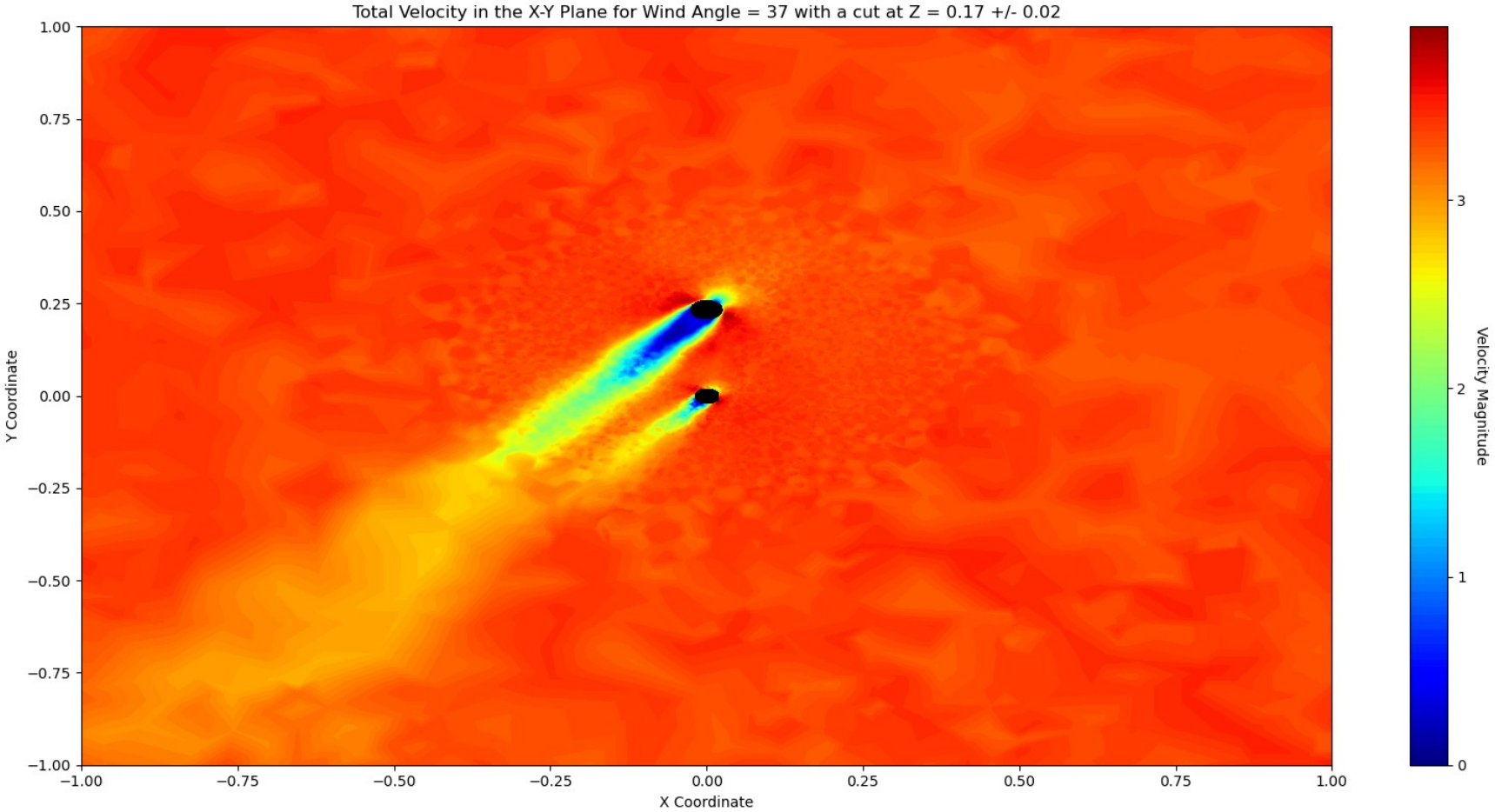
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X Coordinate
Velocity Magnitude
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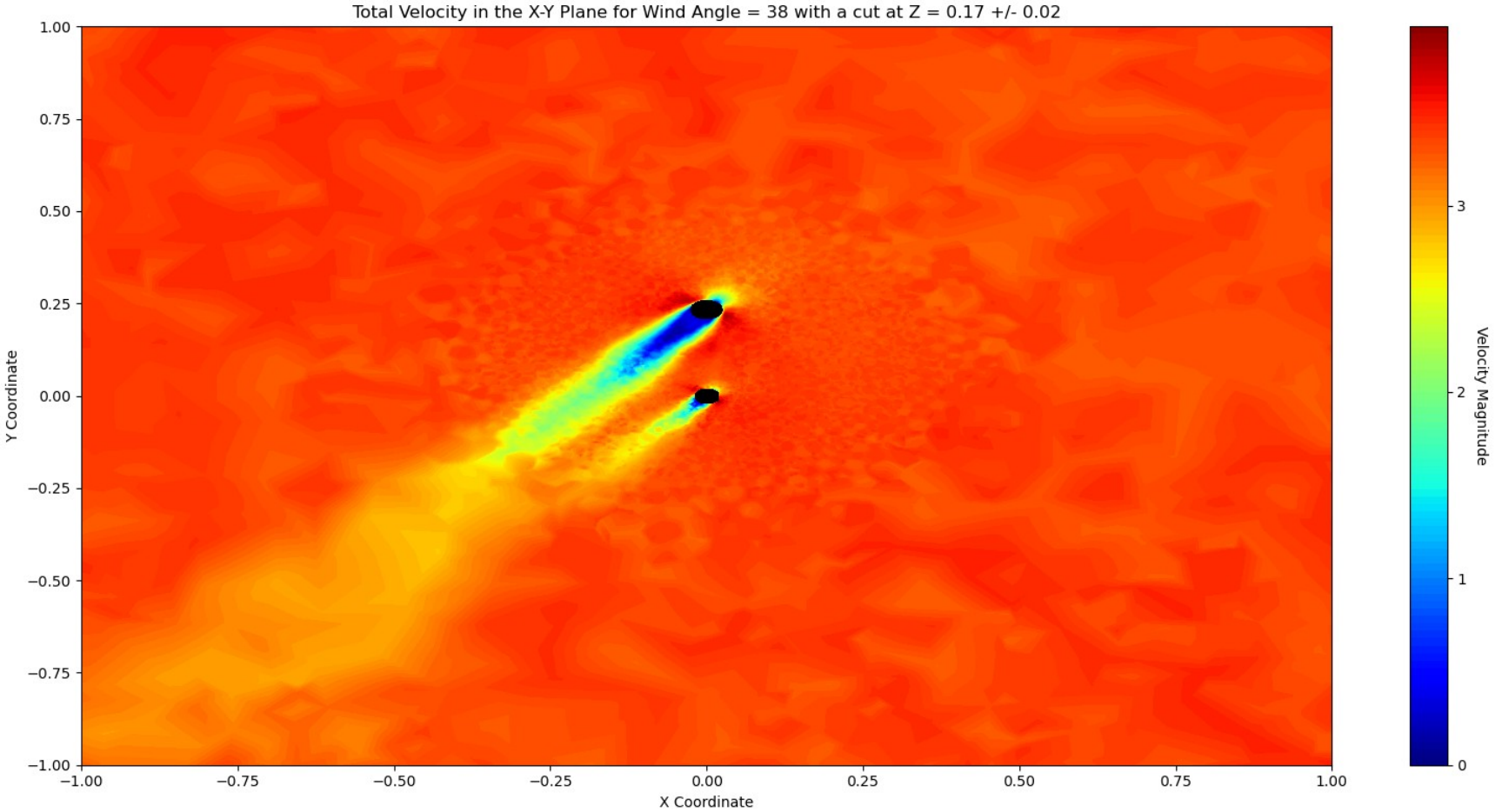
Total Velocity in the X-Y Plane for Wind Angle = 38 with a cut at Z = 0.17 +/- 0.02
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X Coordinate
Velocity Magnitude
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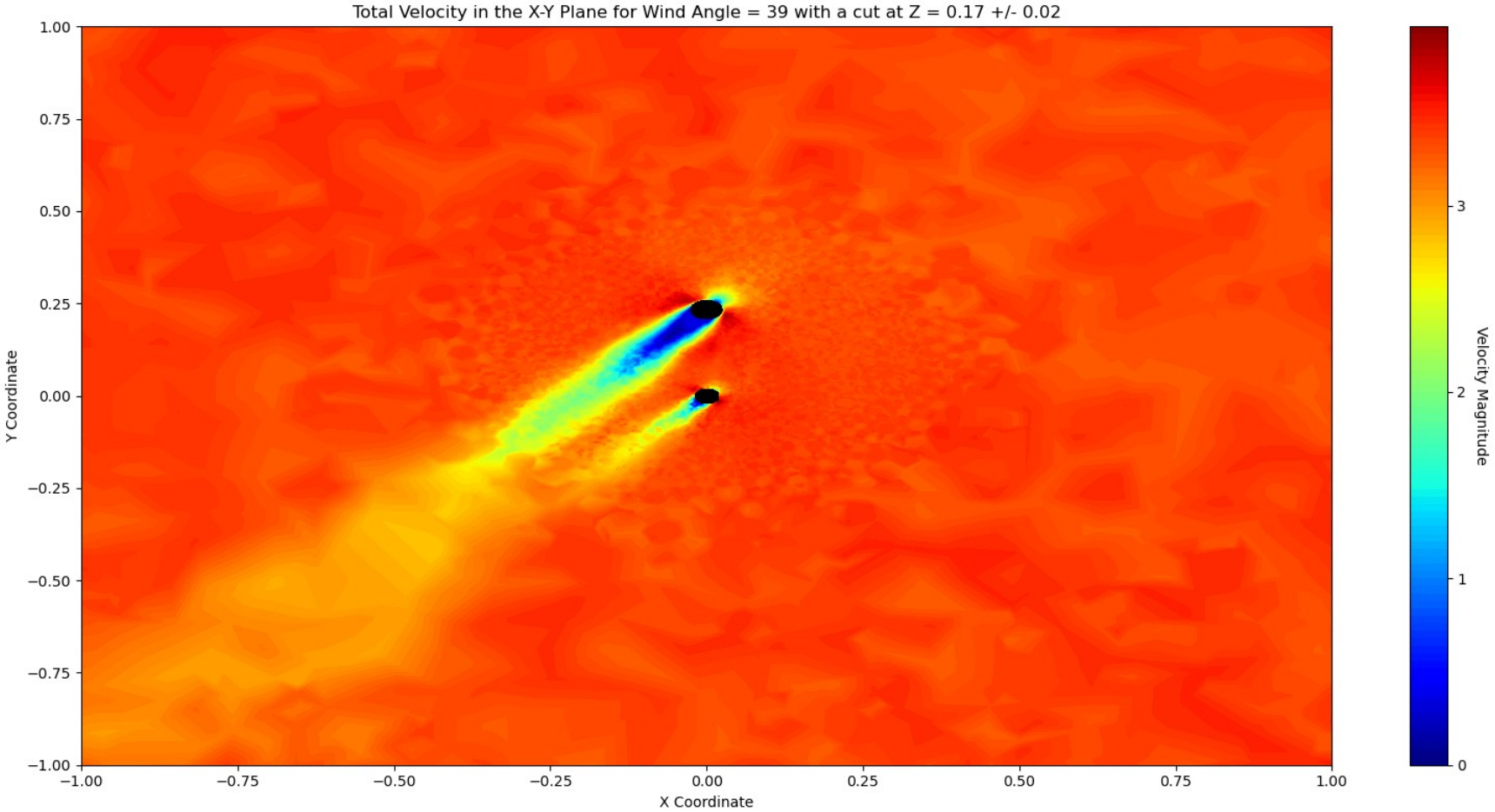
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X Coordinate
Velocity Magnitude
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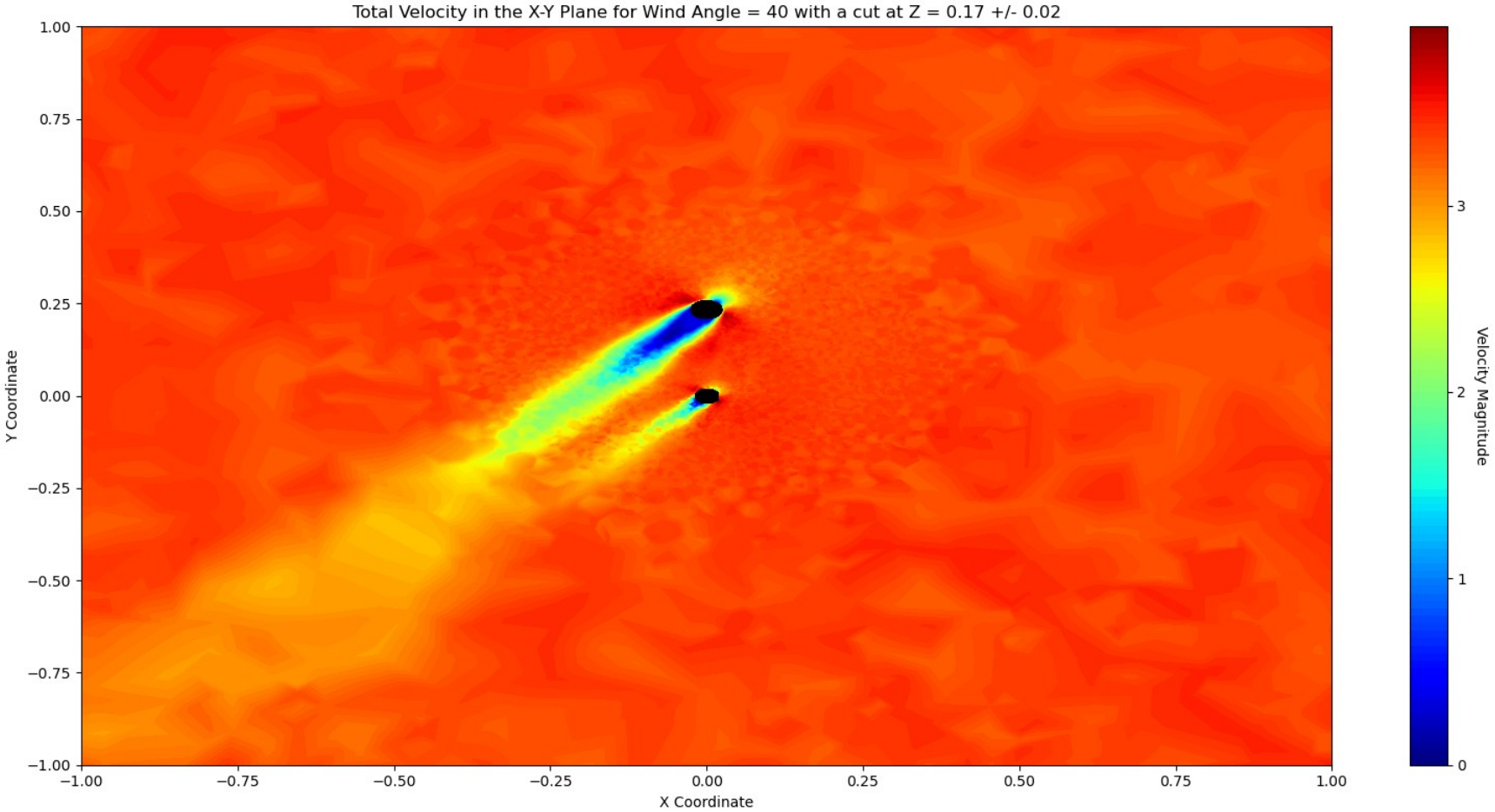
Total Velocity in the X-Y Plane for Wind Angle = 40 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
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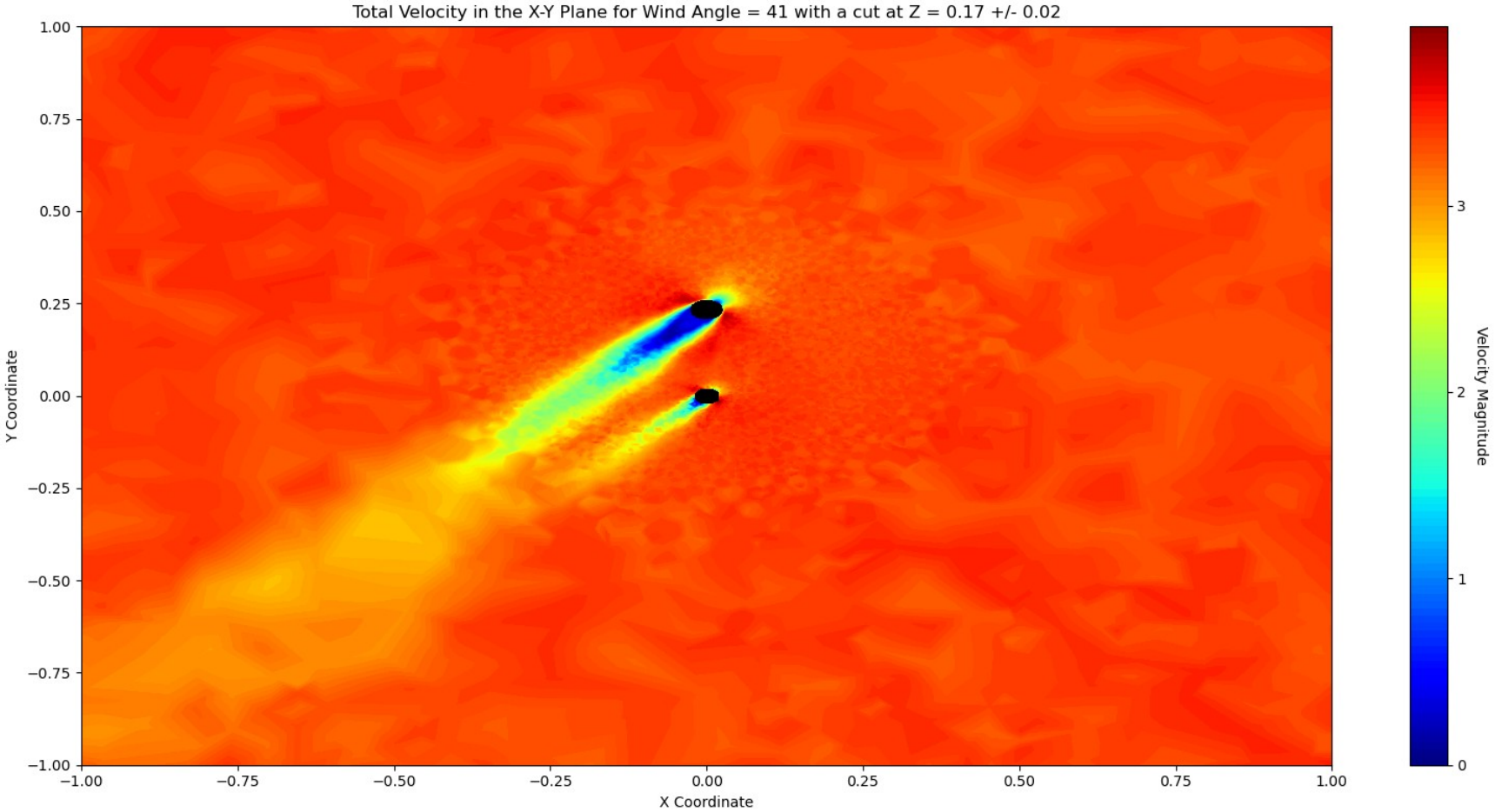
Total Velocity in the X-Y Plane for Wind Angle = 41 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
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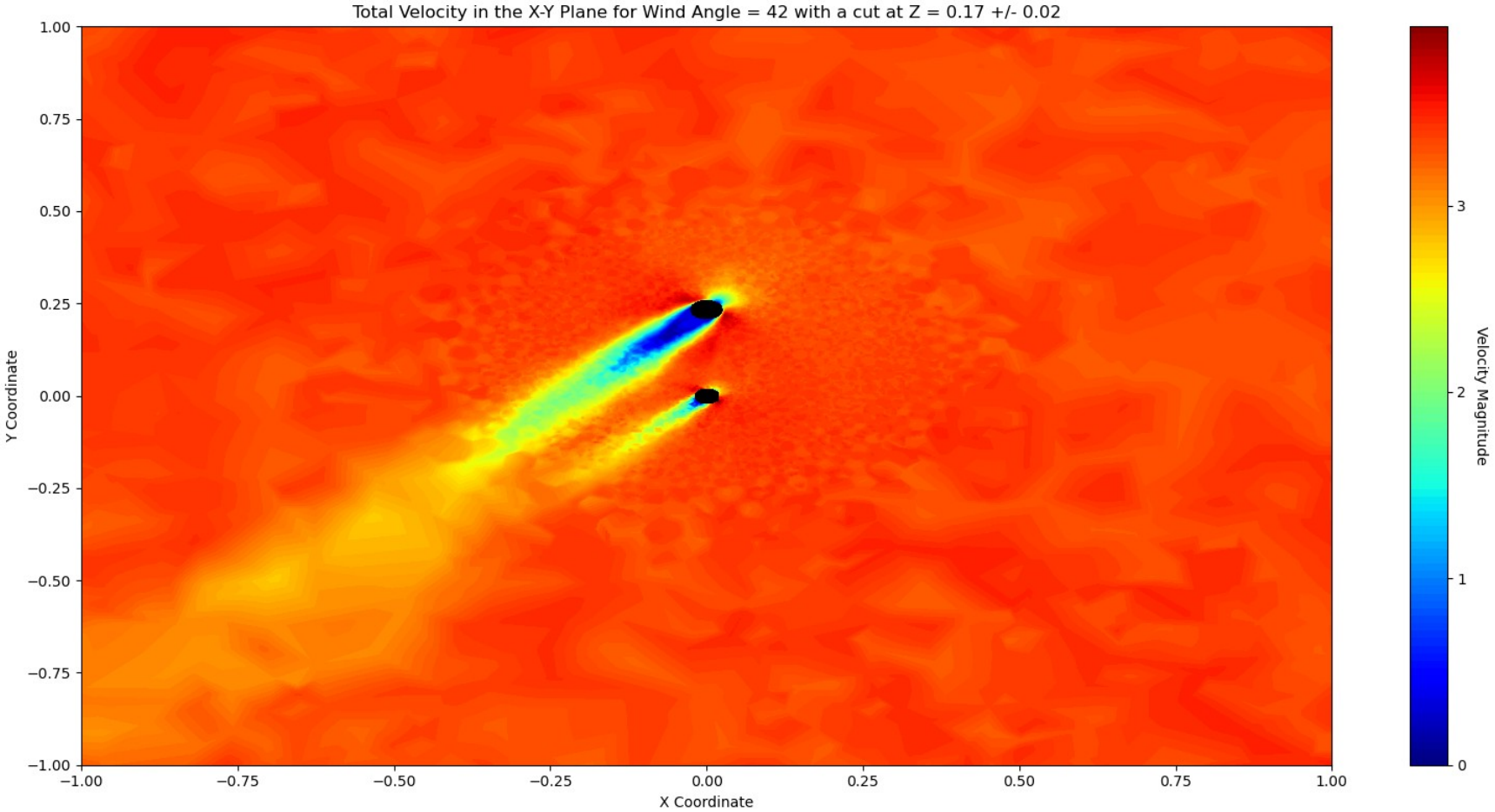
Total Velocity in the X-Y Plane for Wind Angle = 42 with a cut at Z = 0.17 +/- 0.02
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X Coordinate
Velocity Magnitude
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0.25
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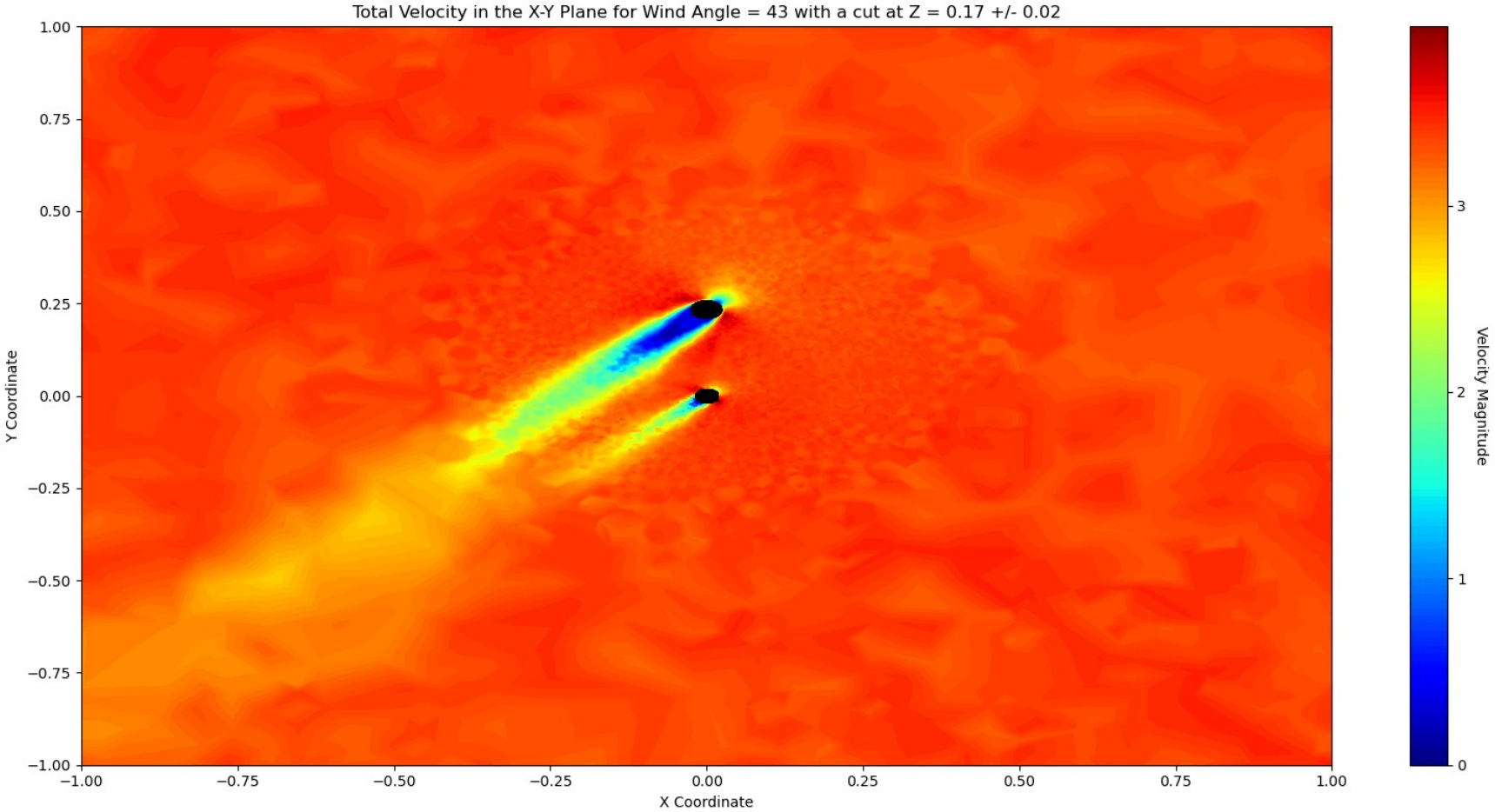
Total Velocity in the X-Y Plane for Wind Angle = 43 with a cut at Z = 0.17 +/- 0.02
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X Coordinate
Velocity Magnitude
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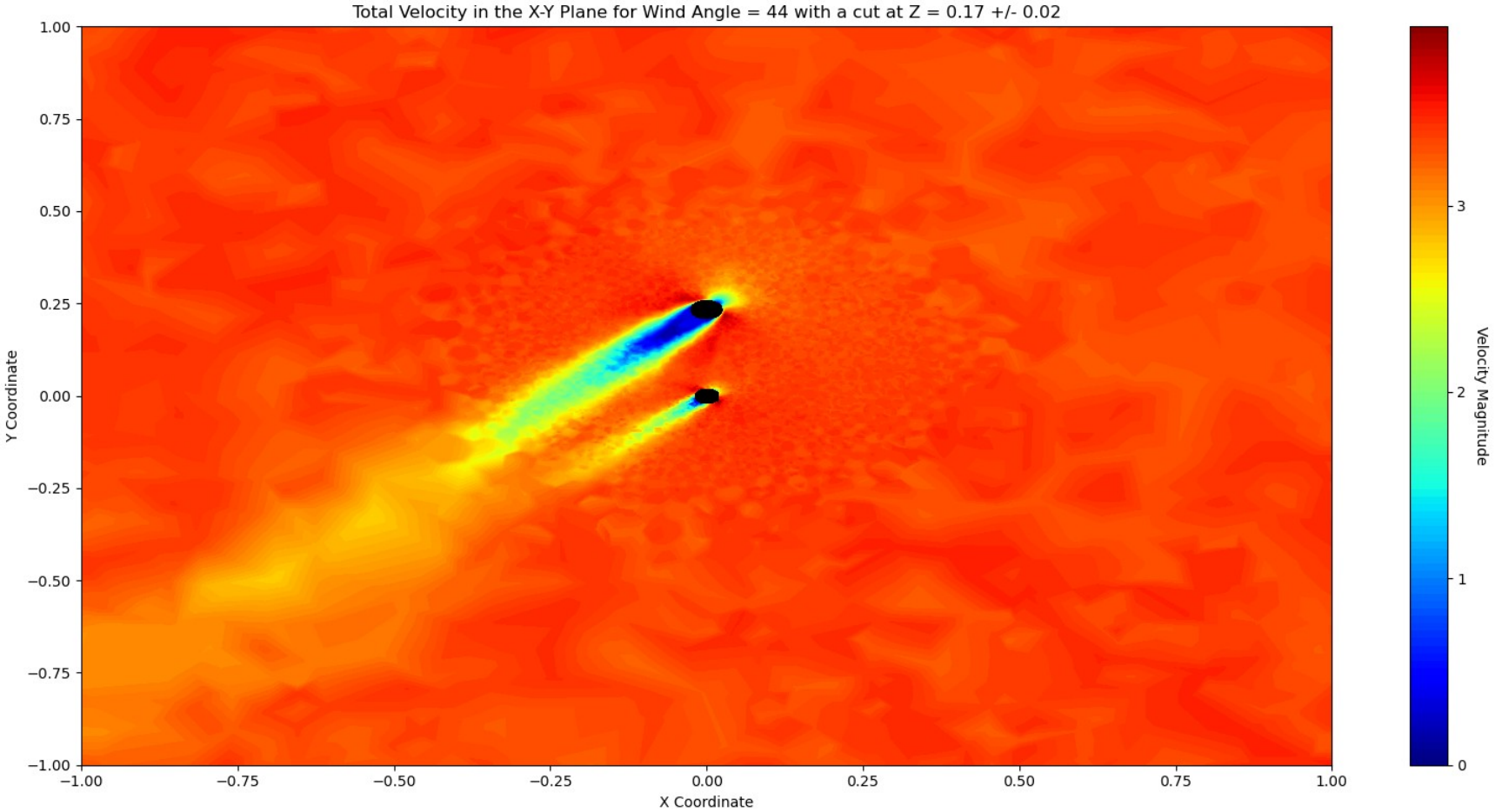
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X Coordinate
Velocity Magnitude
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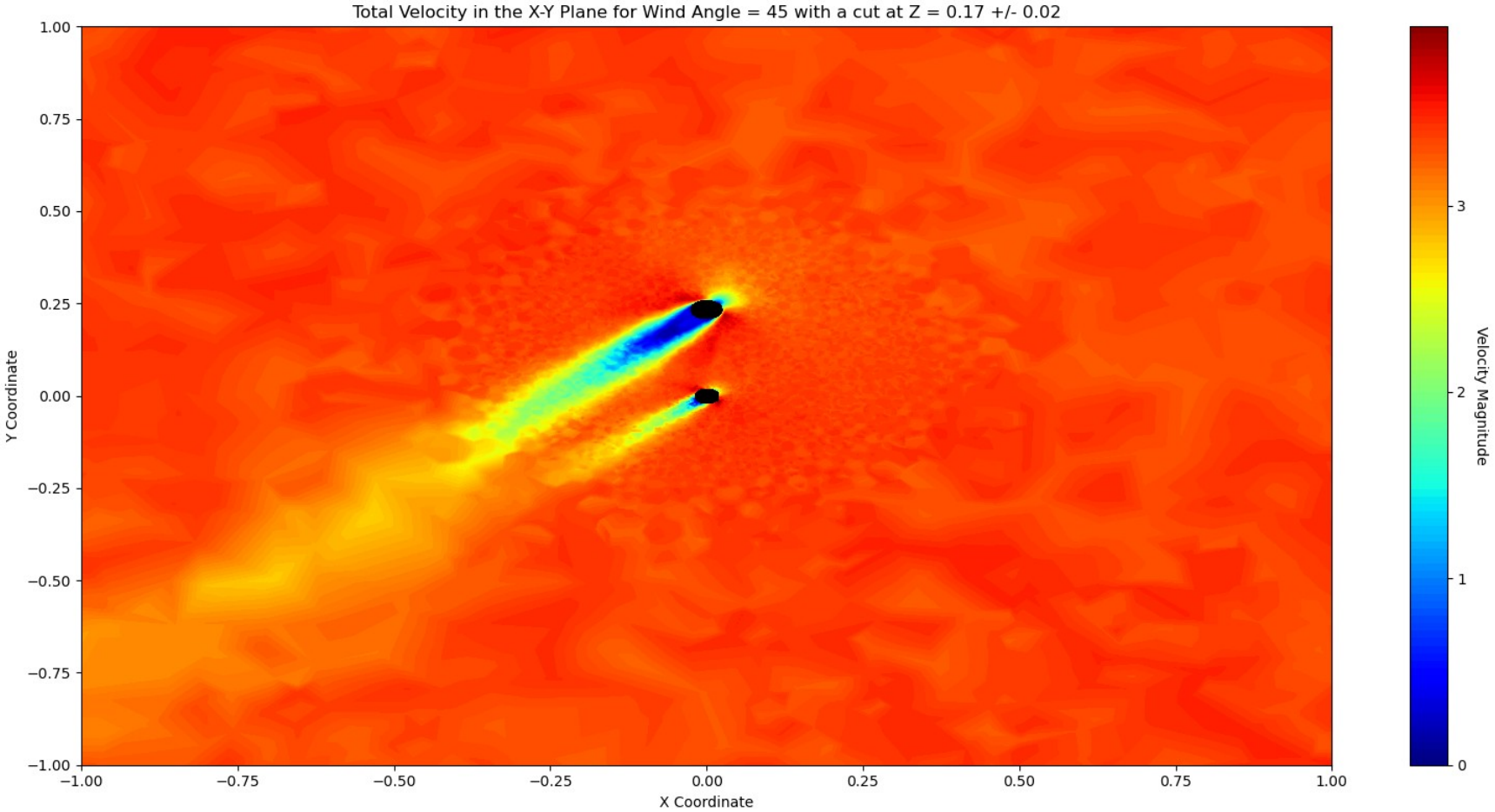
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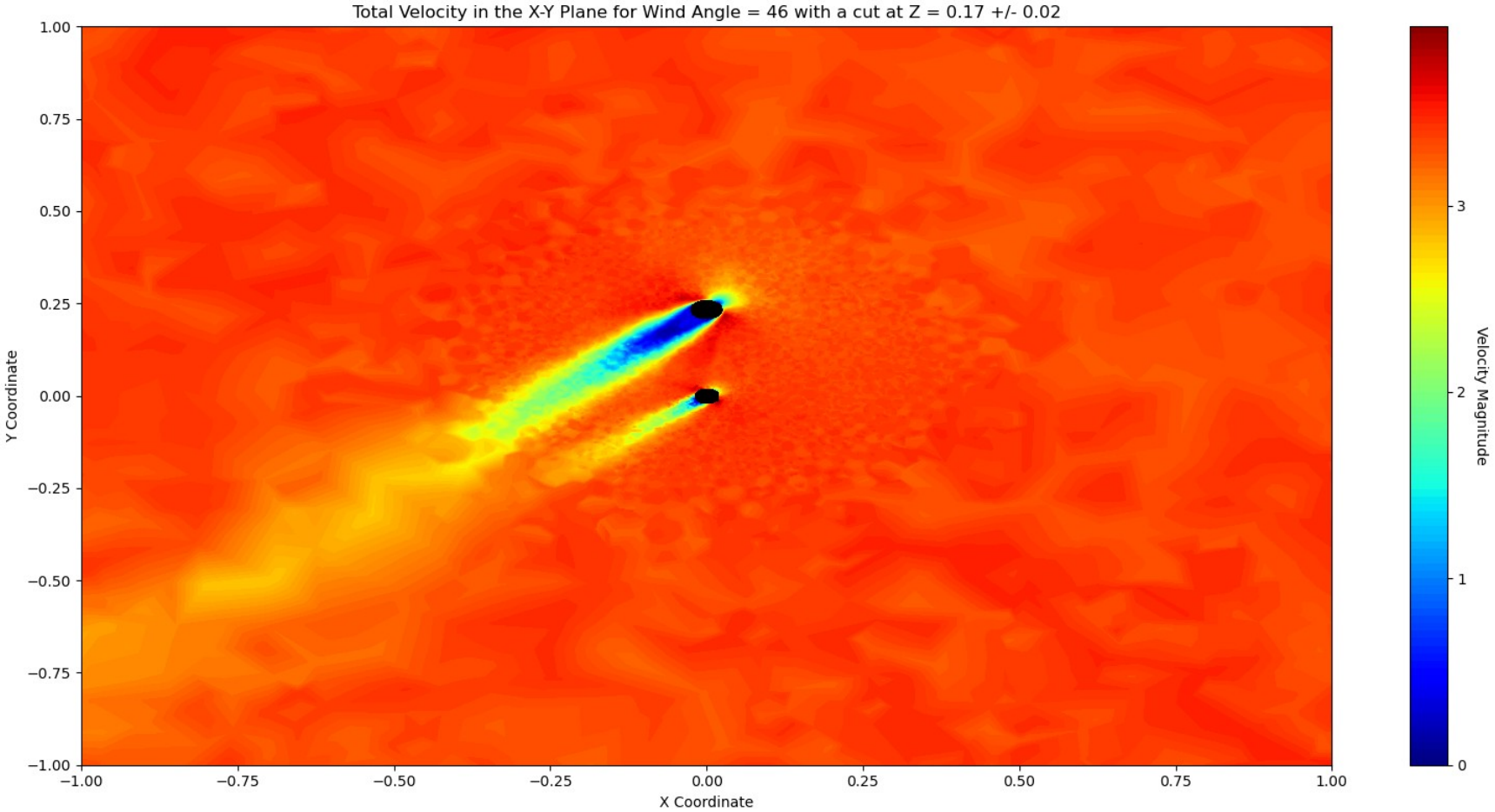
Total Velocity in the X-Y Plane for Wind Angle = 46 with a cut at Z = 0.17 +/- 0.02
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X Coordinate
Velocity Magnitude
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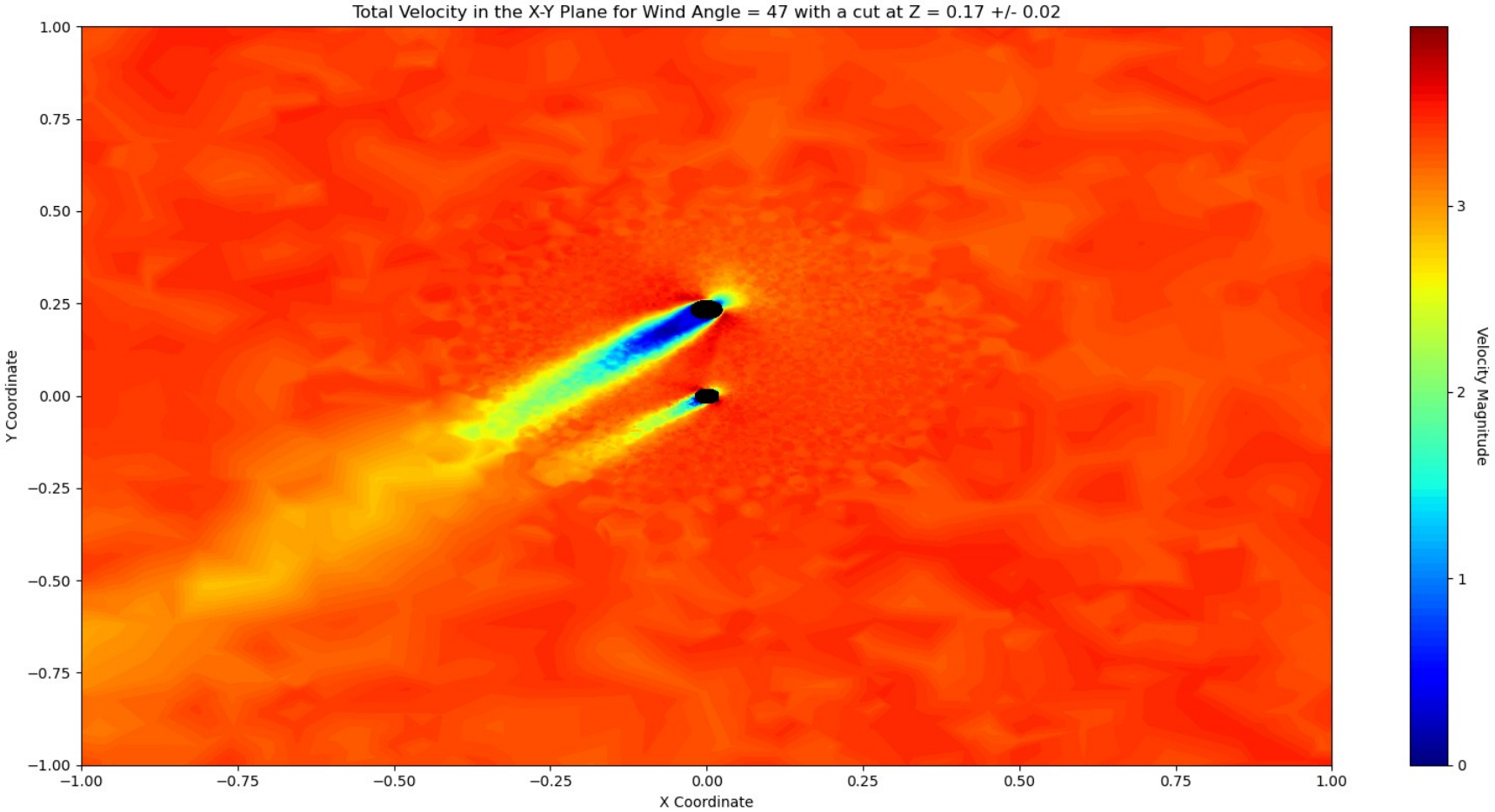
Total Velocity in the X-Y Plane for Wind Angle = 47 with a cut at Z = 0.17 +/- 0.02
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X Coordinate
Velocity Magnitude
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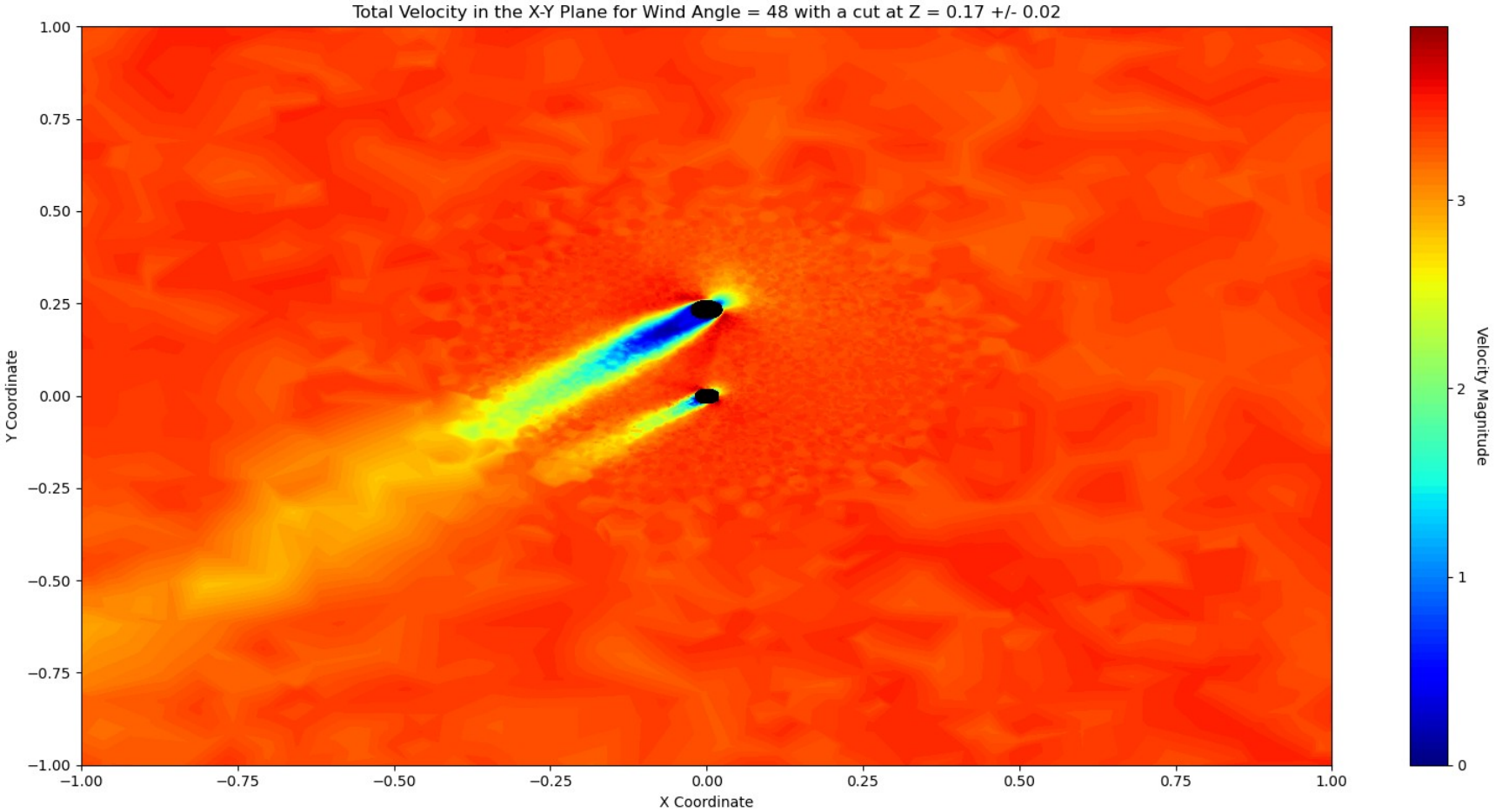
Total Velocity in the X-Y Plane for Wind Angle = 48 with a cut at Z = 0.17 +/- 0.02
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X Coordinate
Velocity Magnitude
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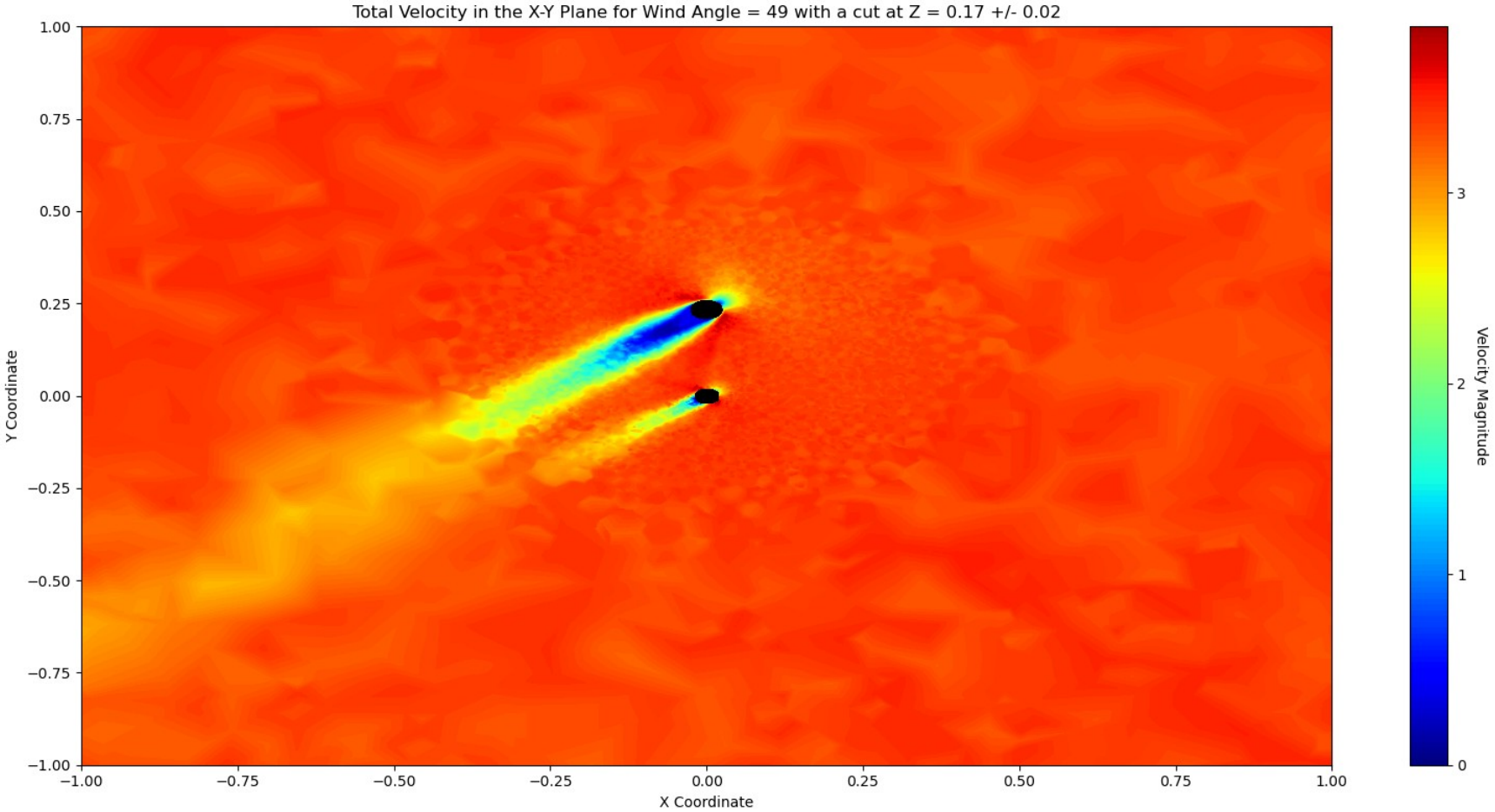
Total Velocity in the X-Y Plane for Wind Angle = 49 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
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−0.75
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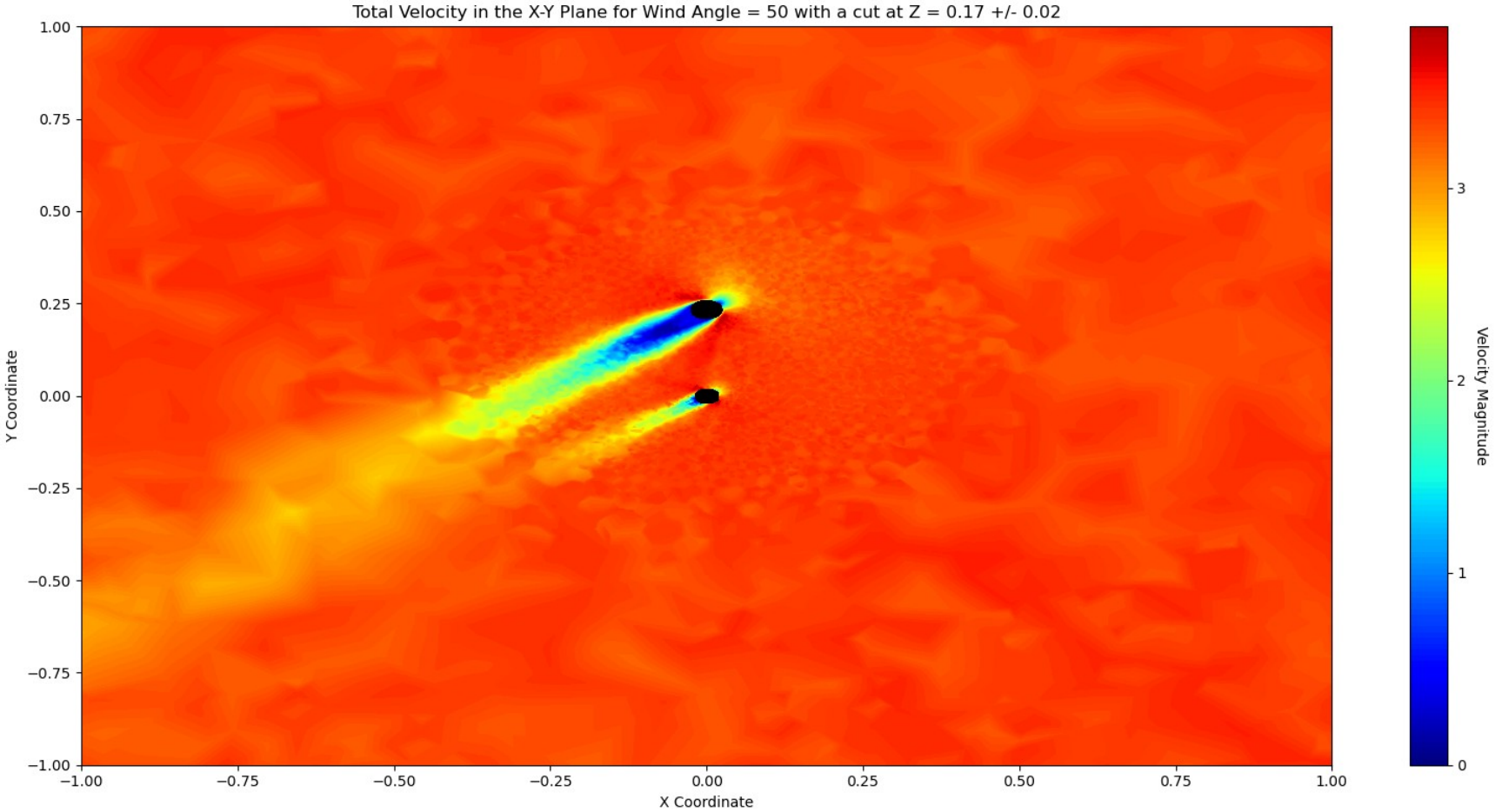
Total Velocity in the X-Y Plane for Wind Angle = 50 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
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0.75
0.50
0.25
0.00
−0.25
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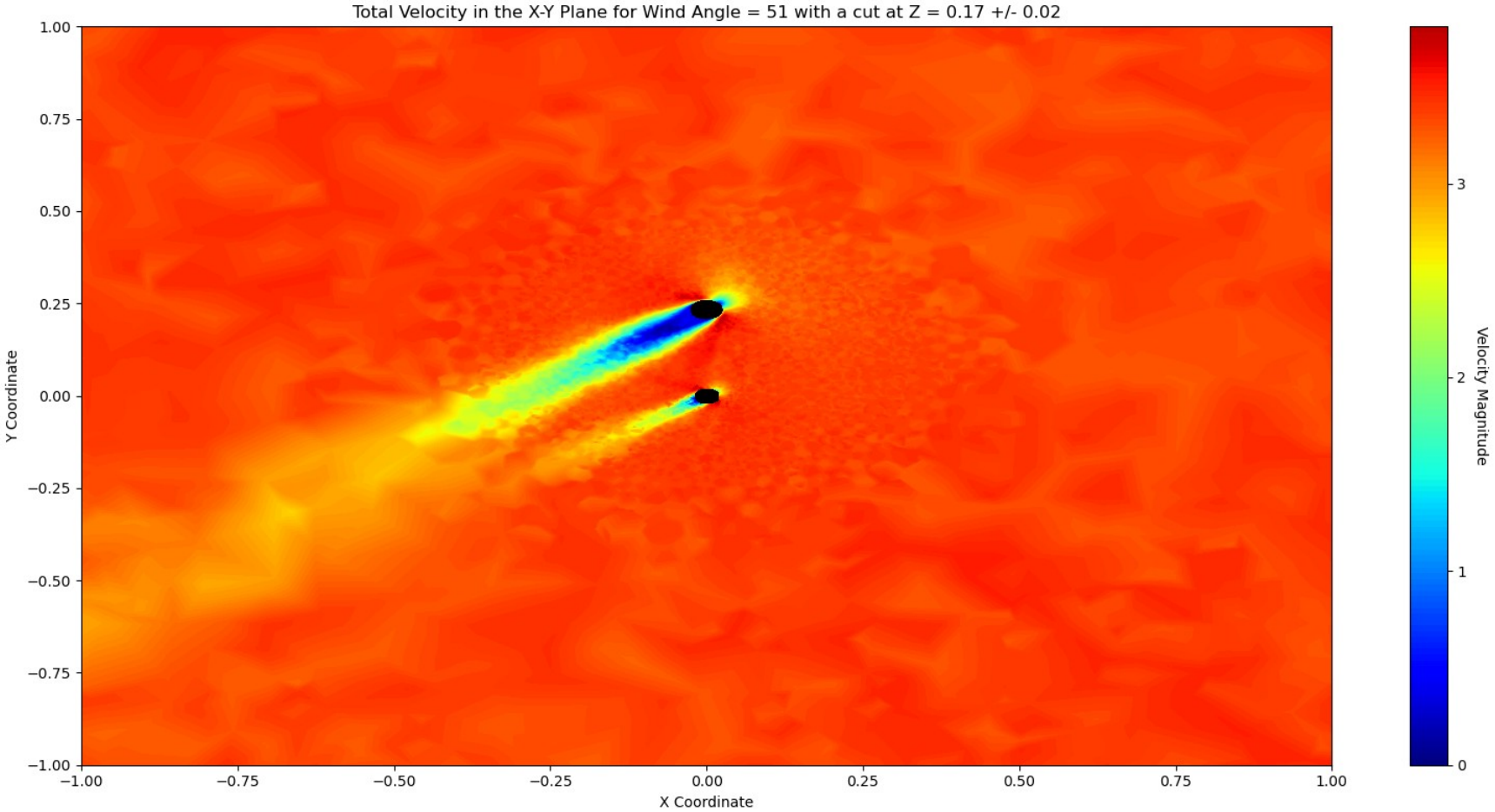
Total Velocity in the X-Y Plane for Wind Angle = 51 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
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0.50
0.25
0.00
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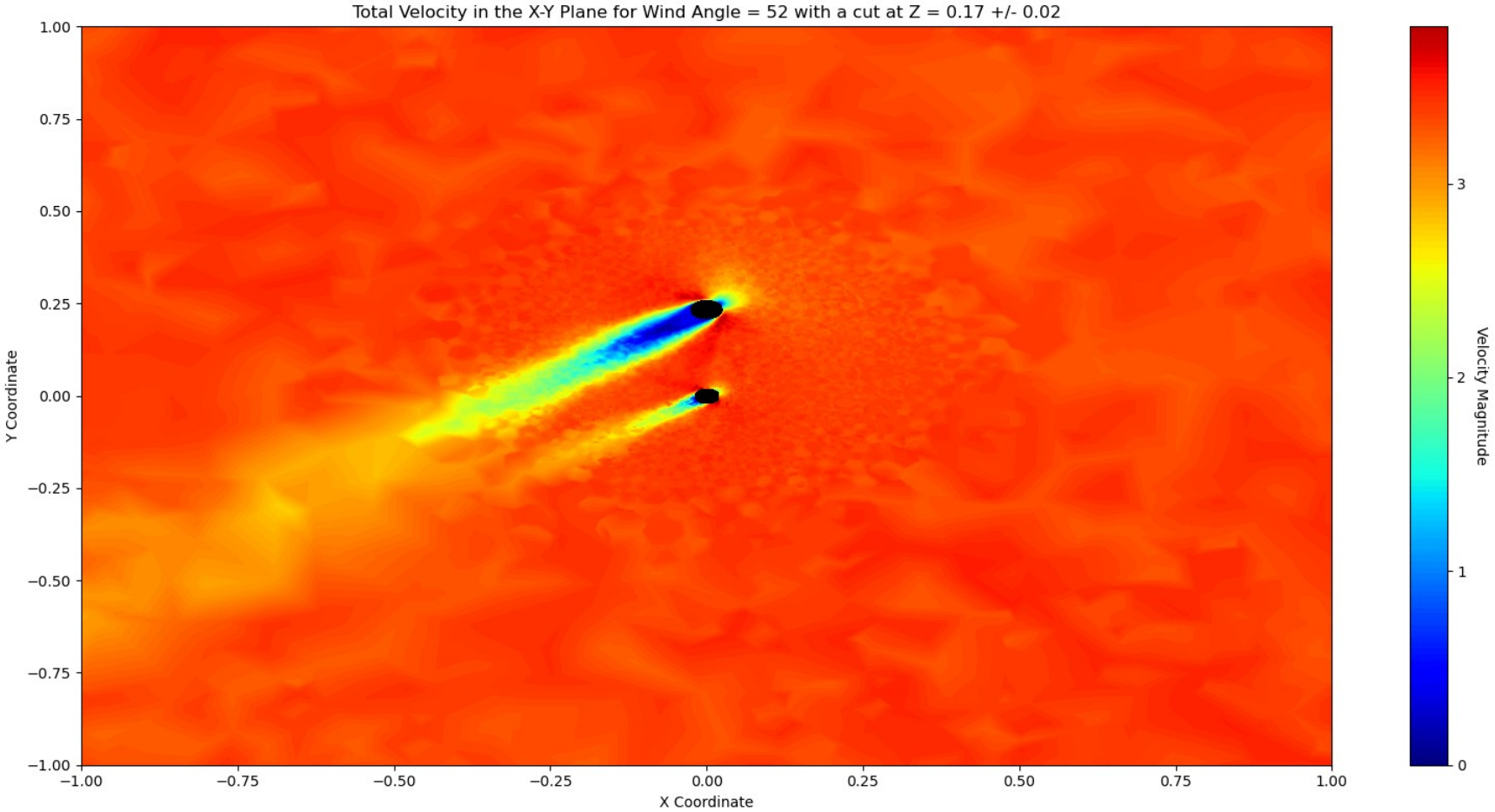
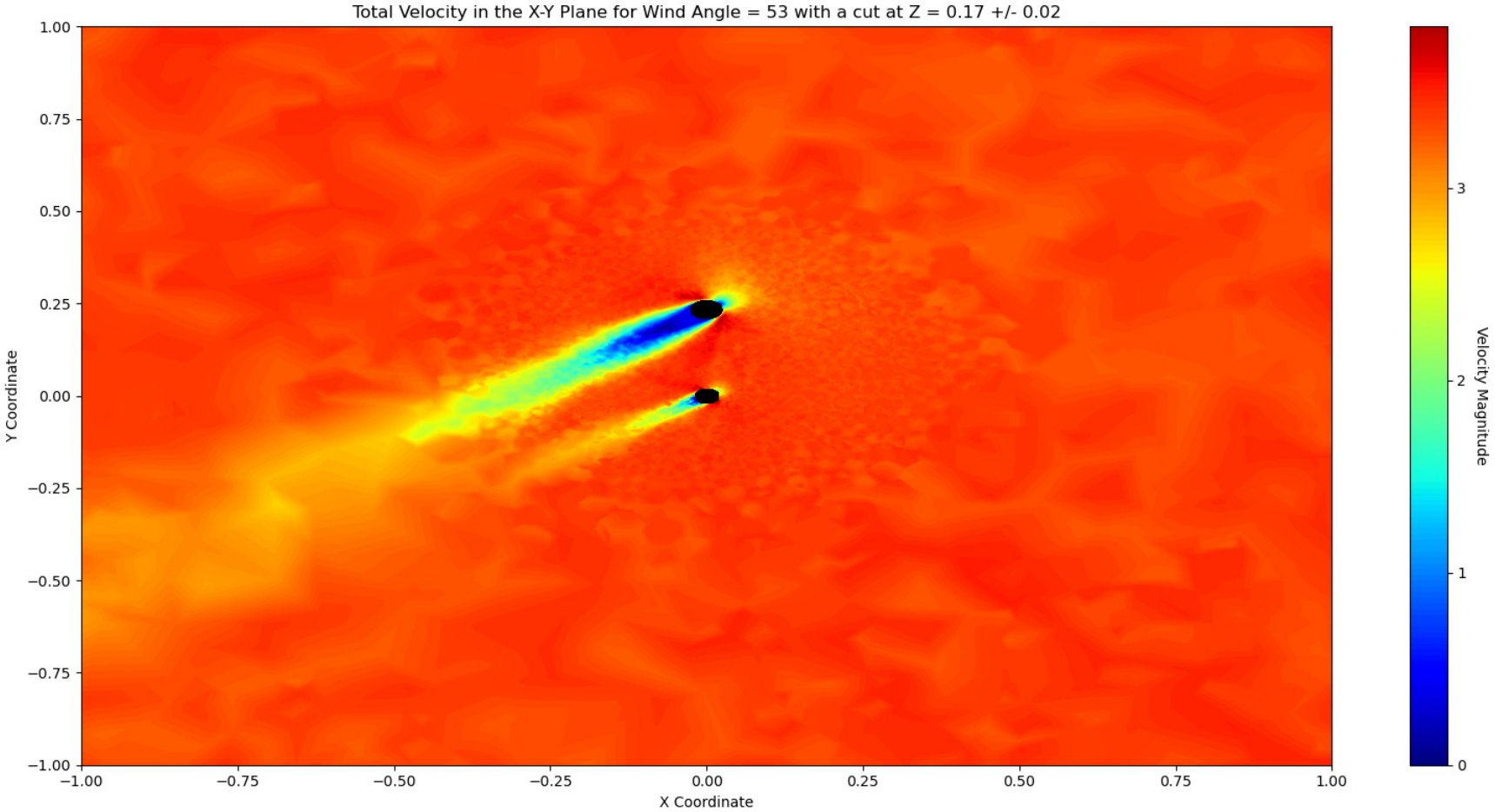
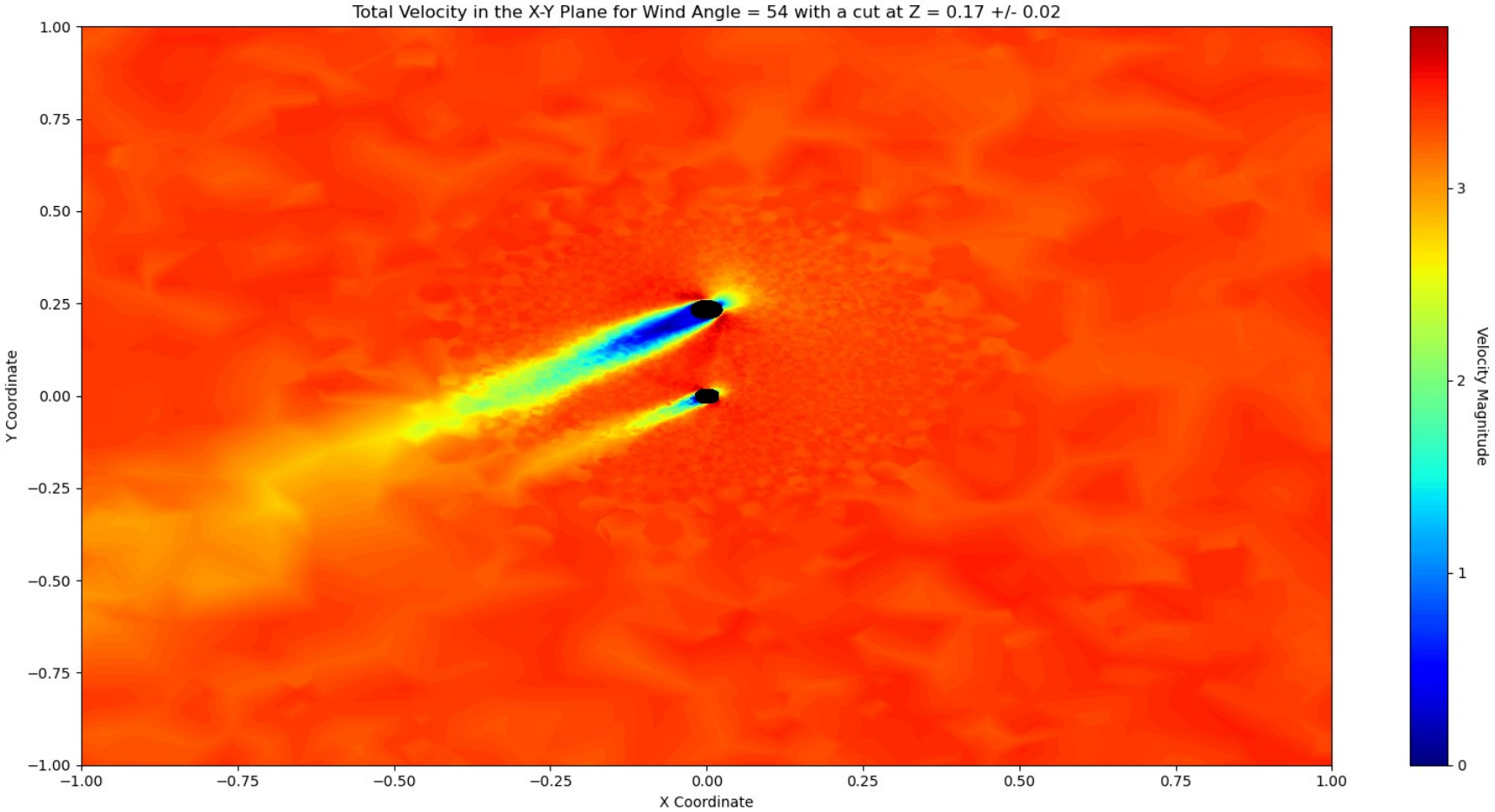
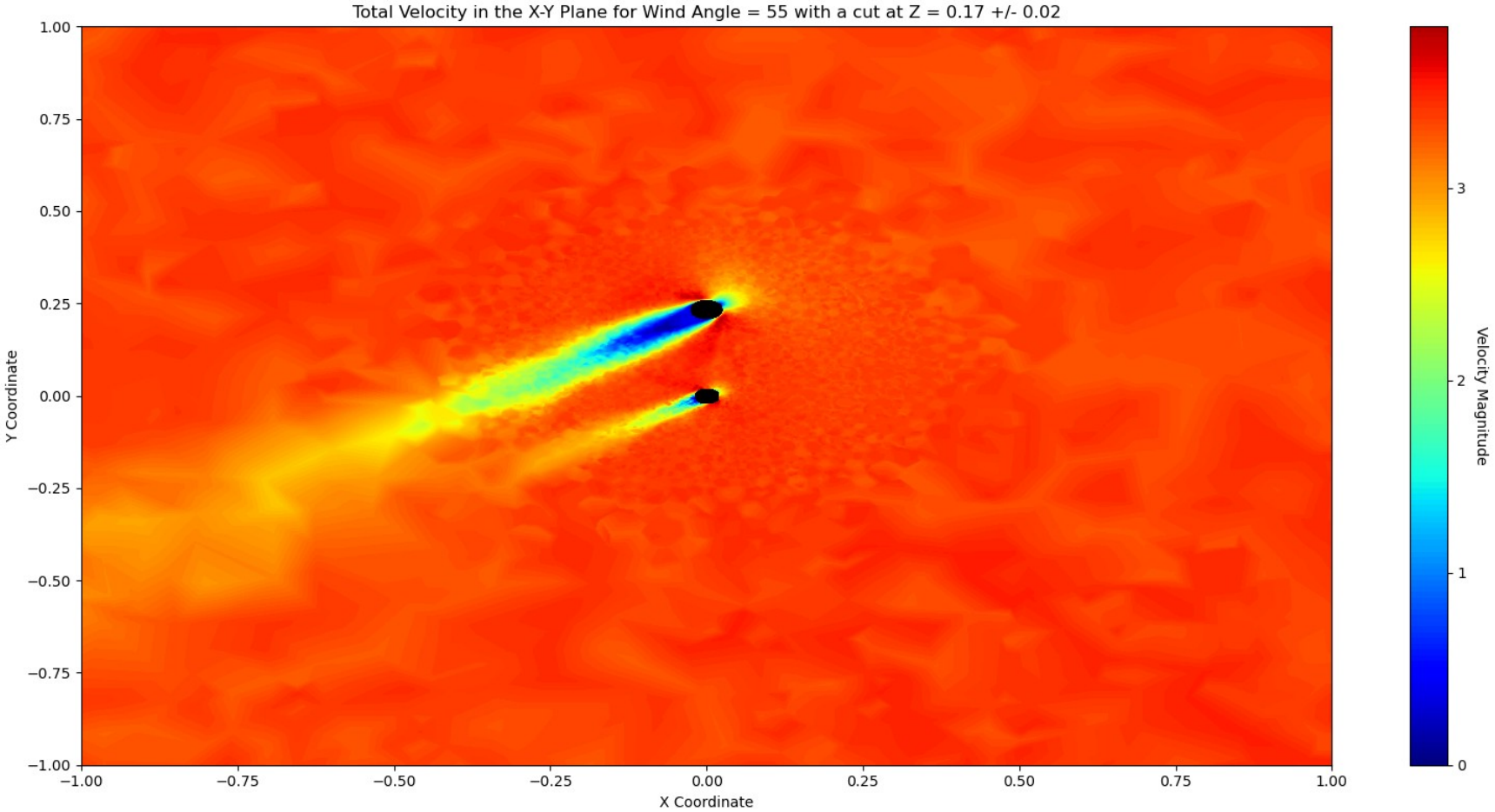
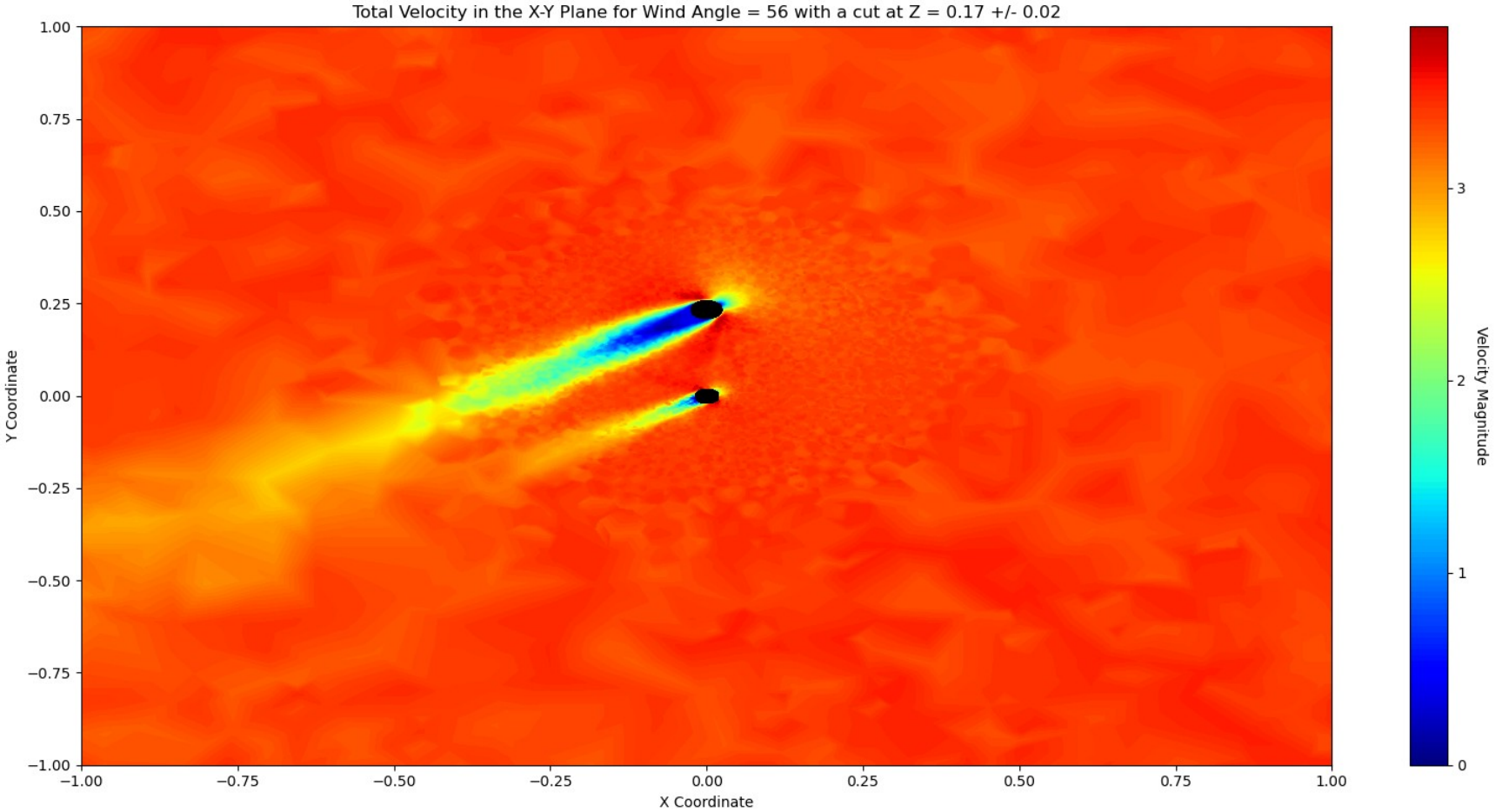
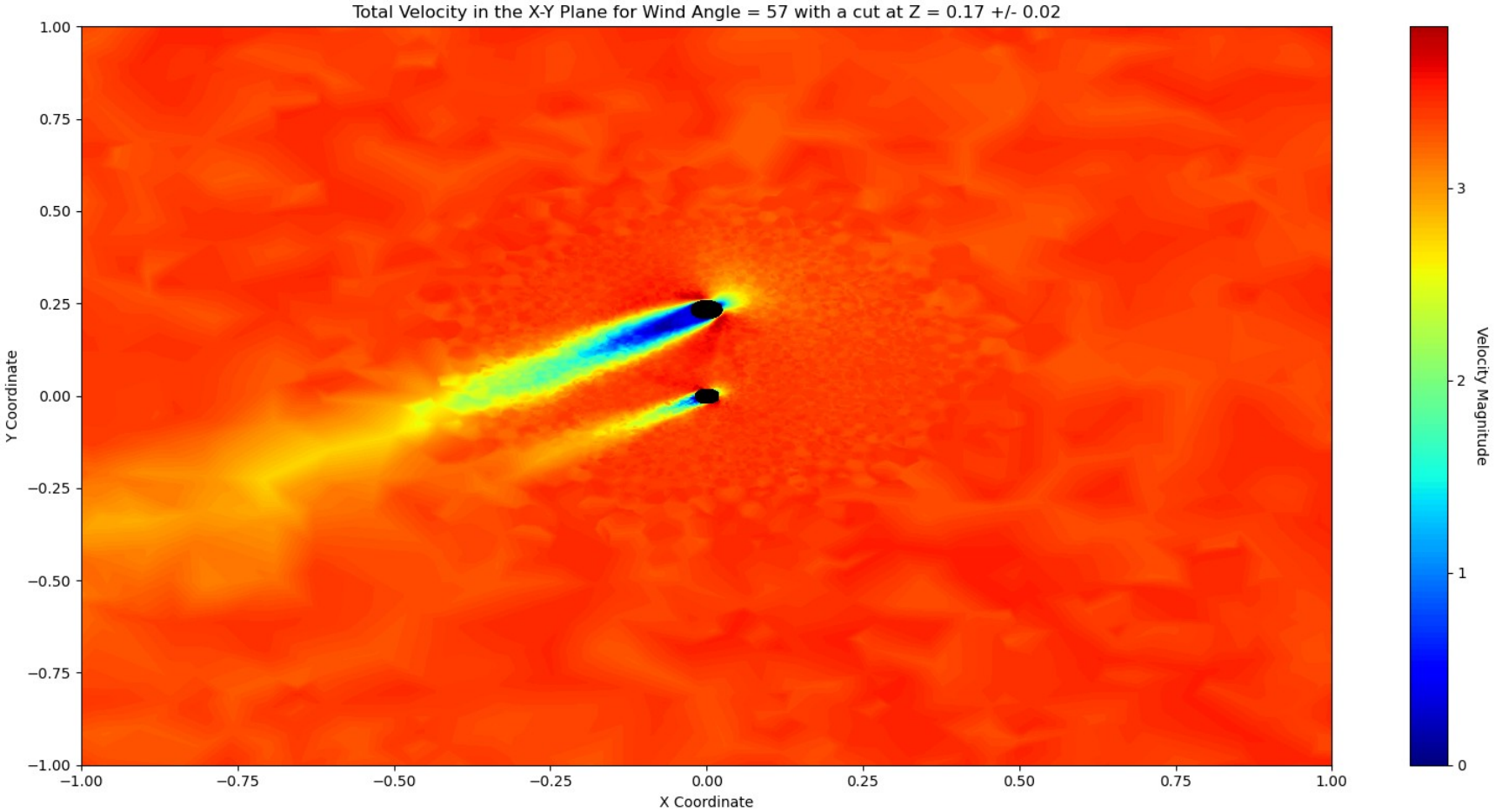

Total Velocity in the X-Y Plane for Wind Angle = 52 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

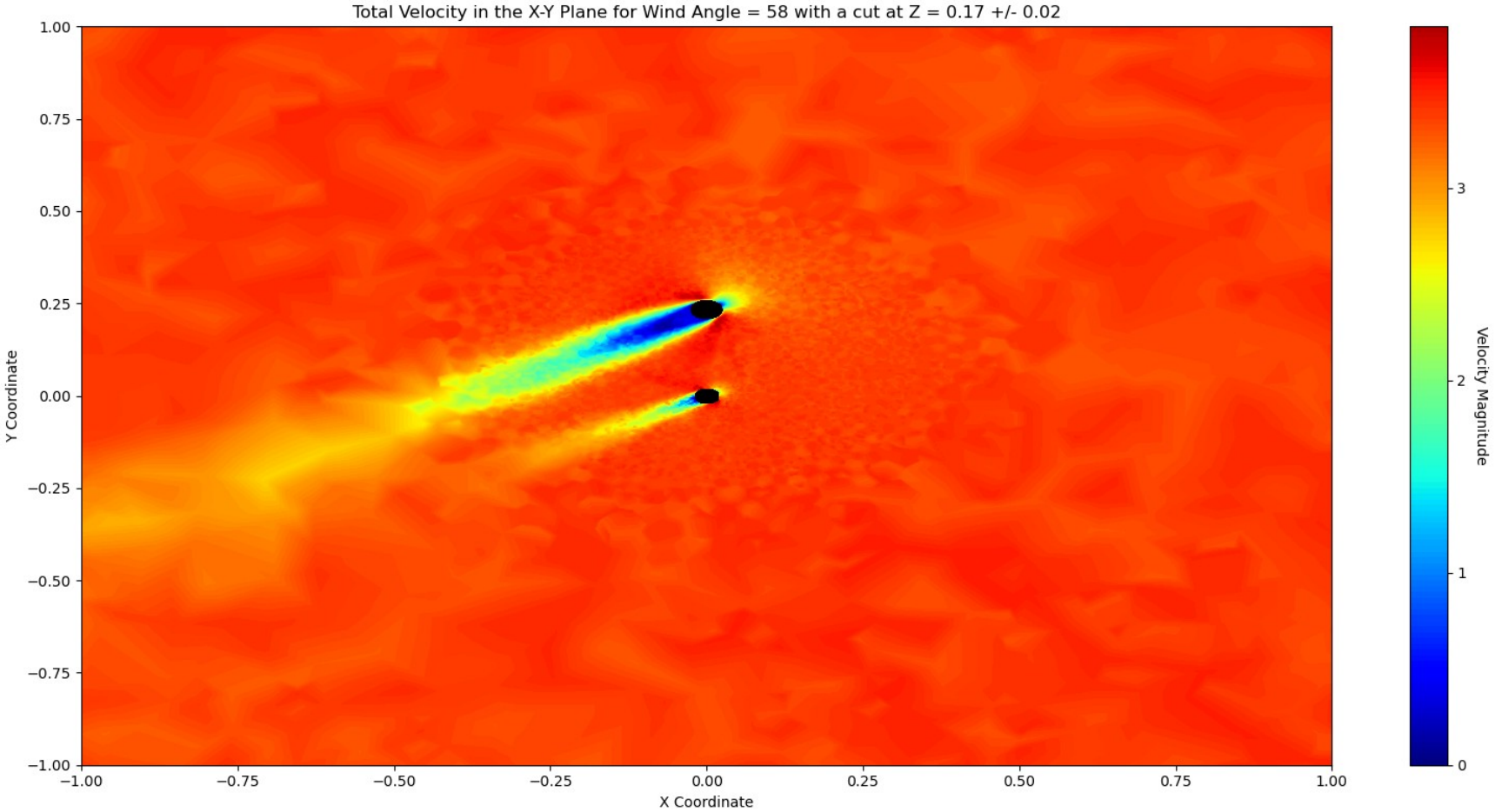

Total Velocity in the X-Y Plane for Wind Angle = 53 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

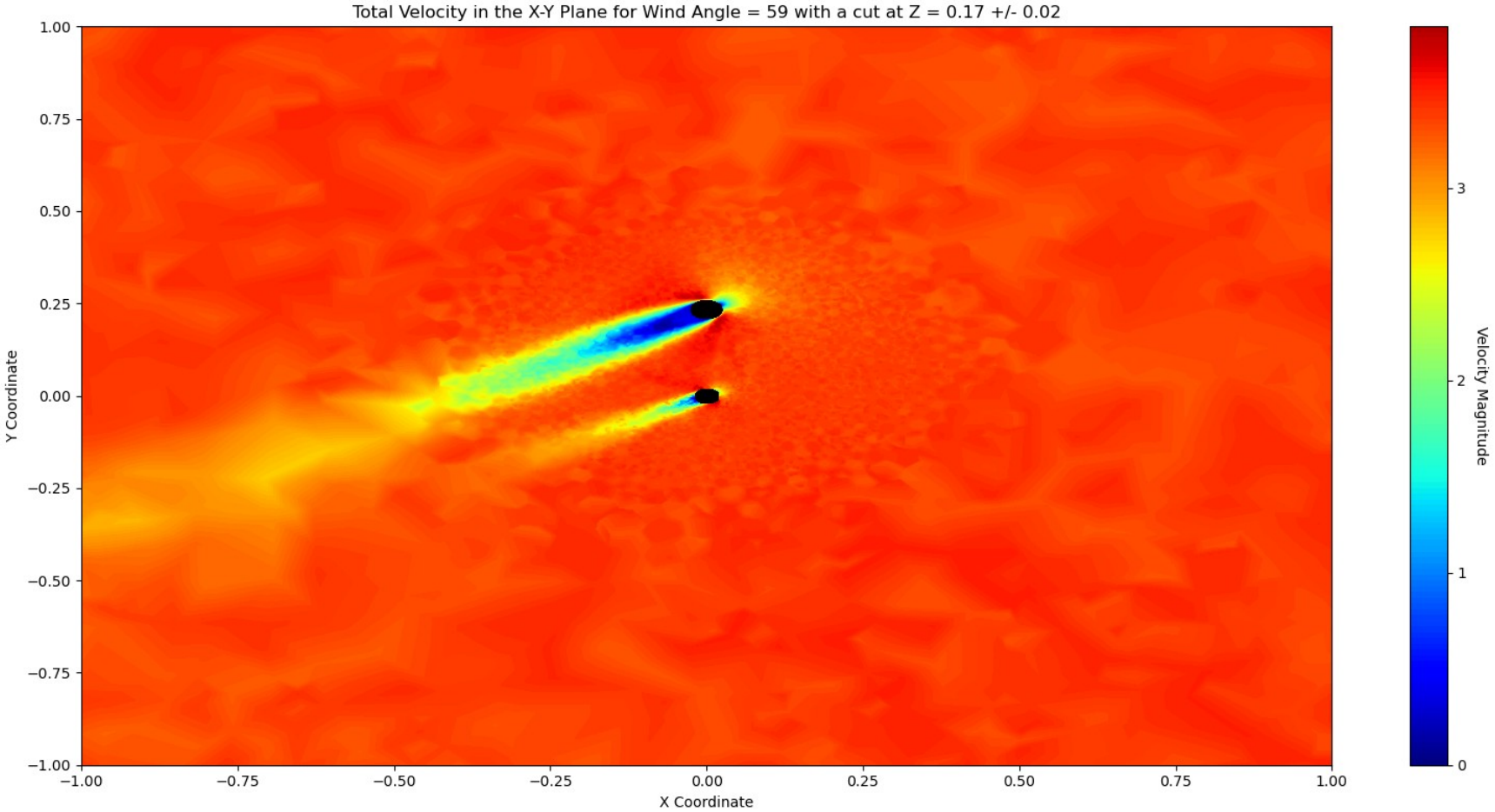

Total Velocity in the X-Y Plane for Wind Angle = 54 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

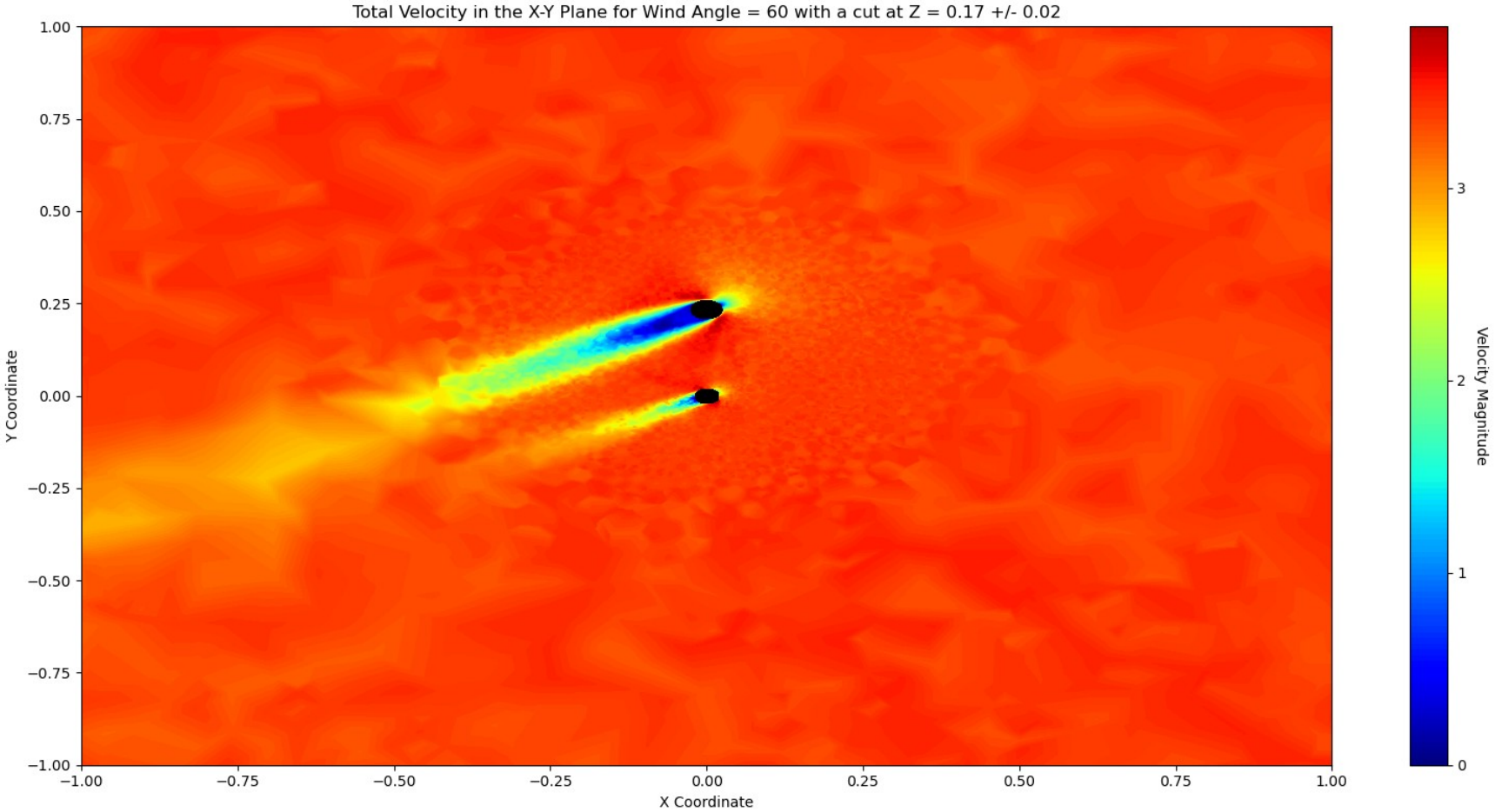

Total Velocity in the X-Y Plane for Wind Angle = 55 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

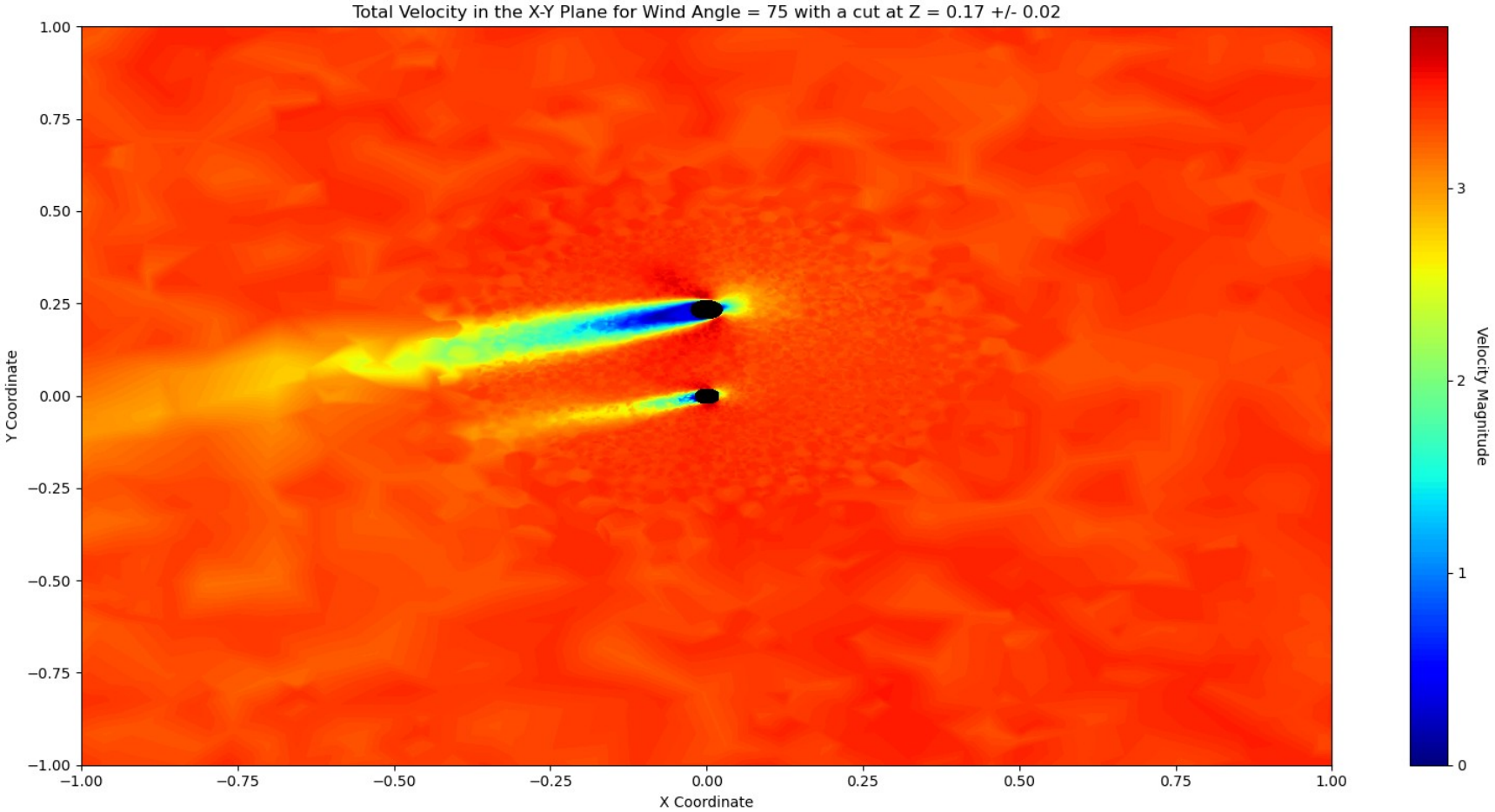

Total Velocity in the X-Y Plane for Wind Angle = 56 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

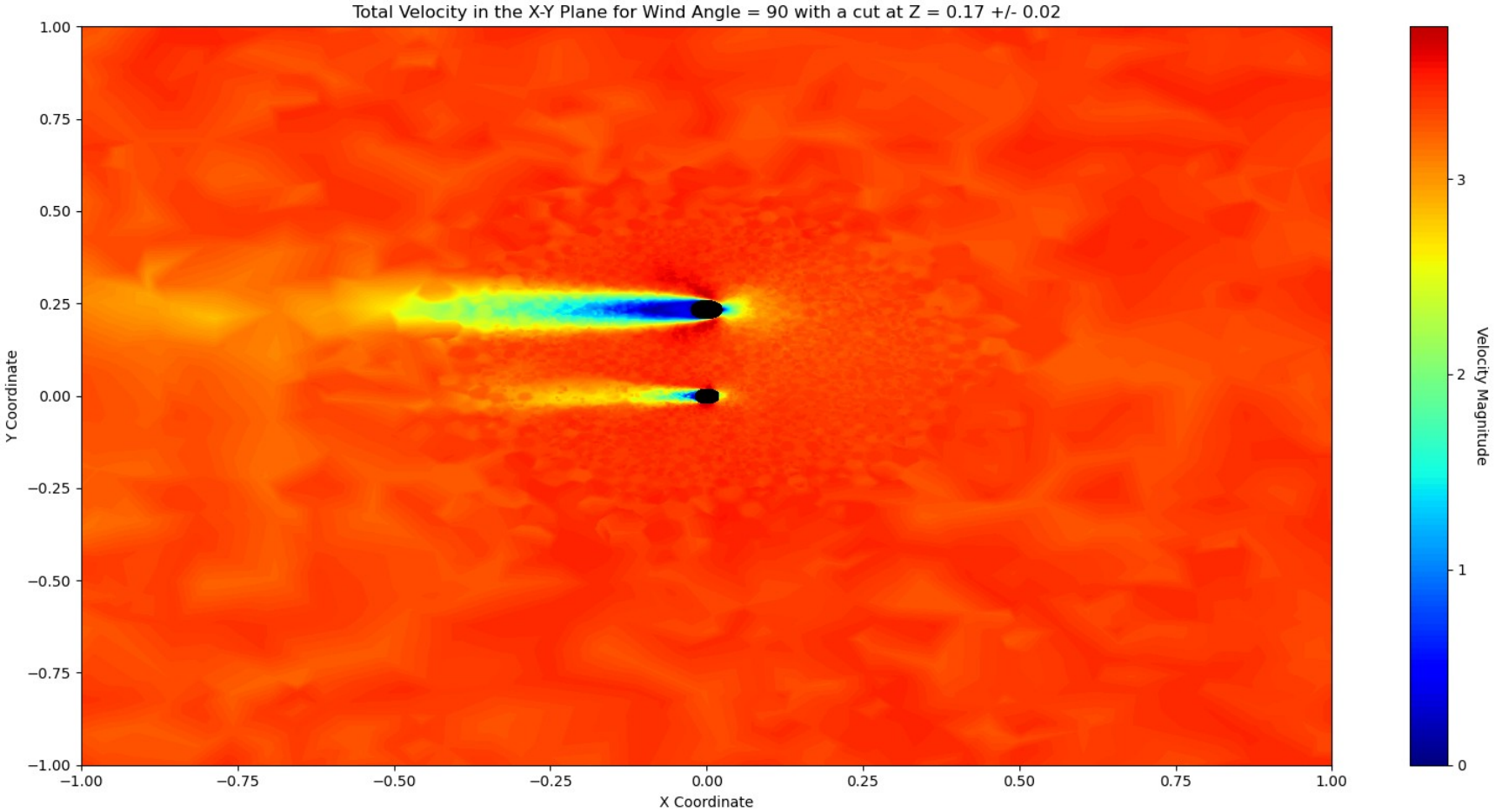

Total Velocity in the X-Y Plane for Wind Angle = 57 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

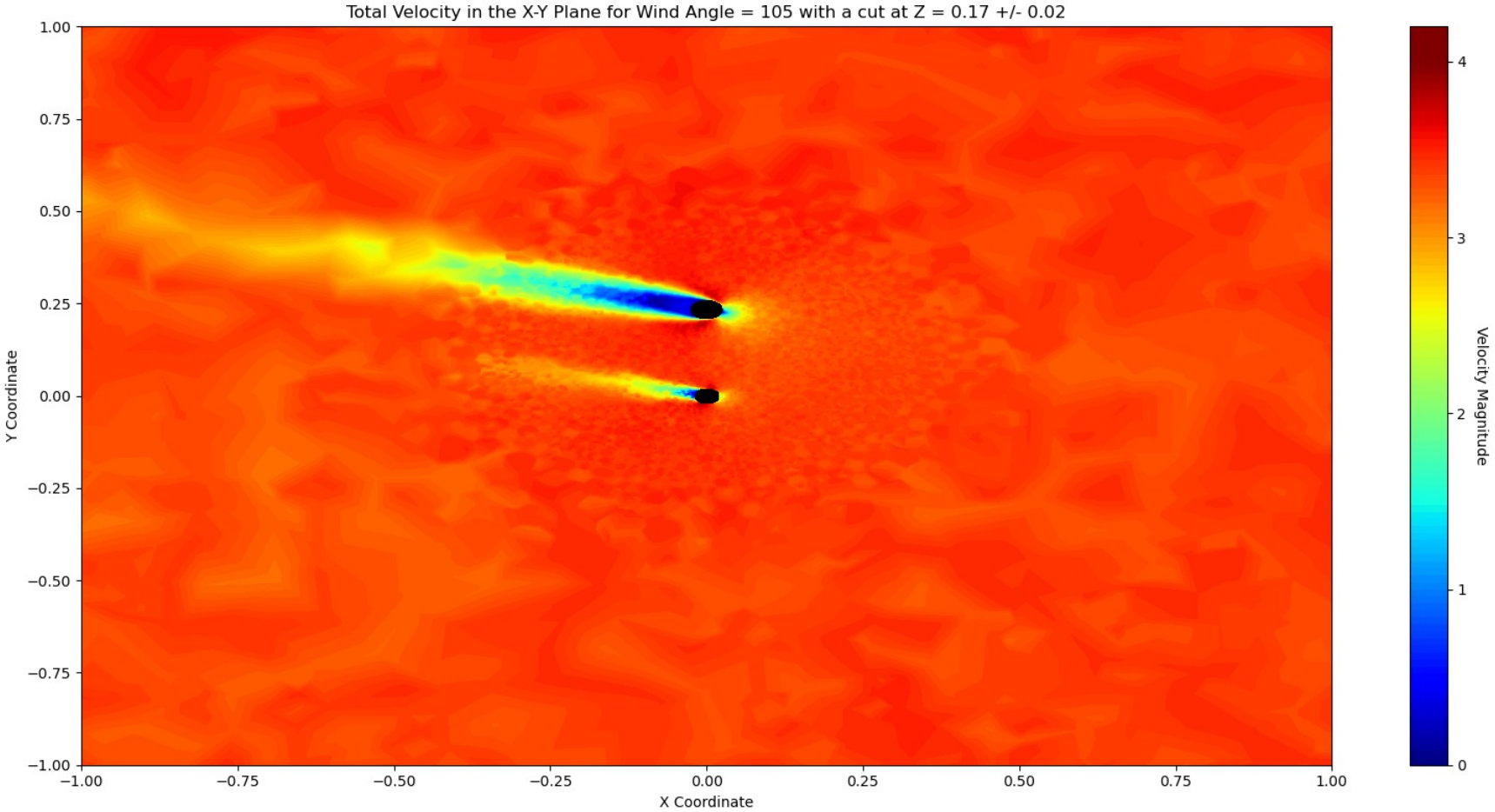

Total Velocity in the X-Y Plane for Wind Angle = 58 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

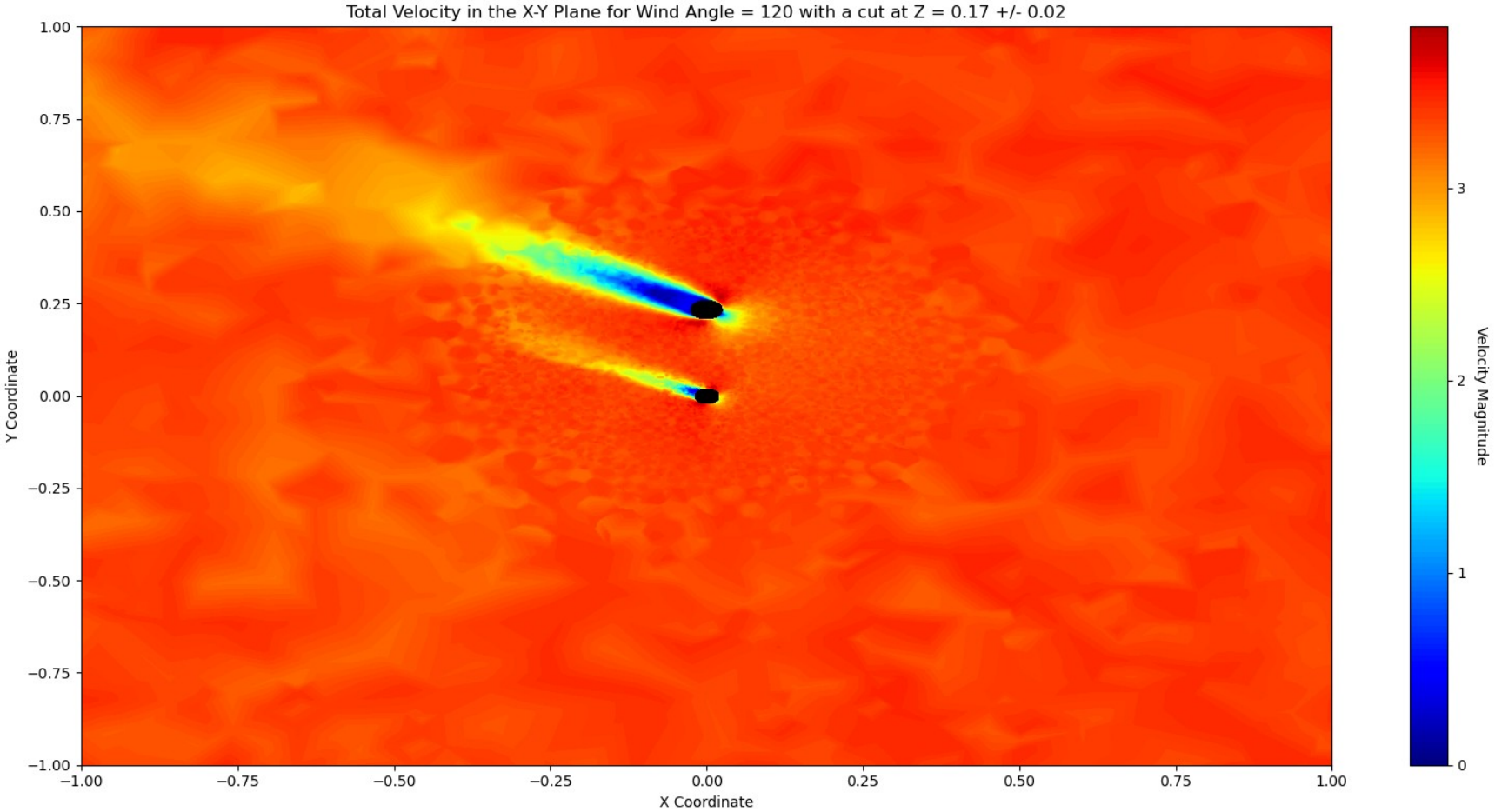

Total Velocity in the X-Y Plane for Wind Angle = 59 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

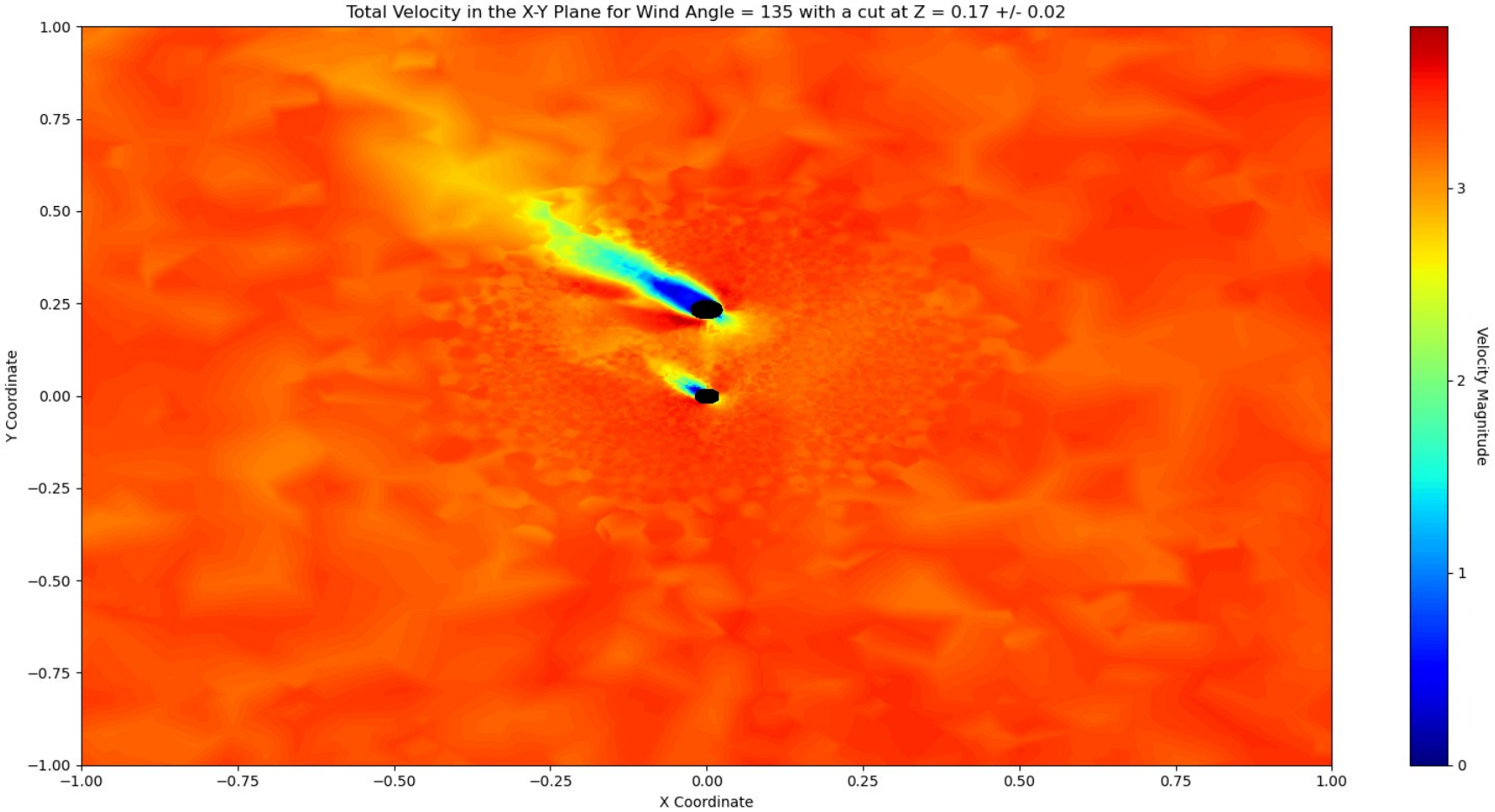

Total Velocity in the X-Y Plane for Wind Angle = 60 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

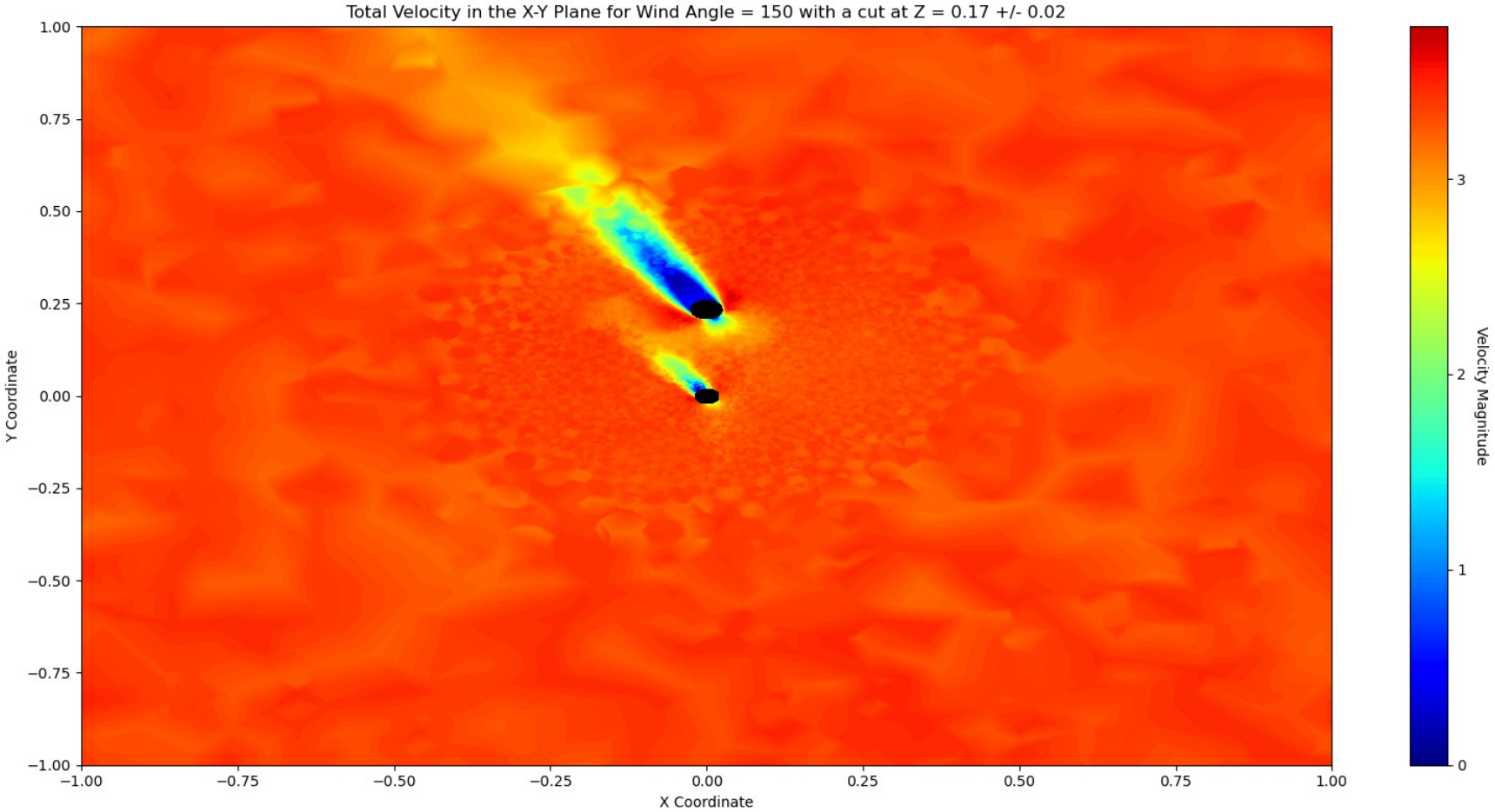

Total Velocity in the X-Y Plane for Wind Angle = 75 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

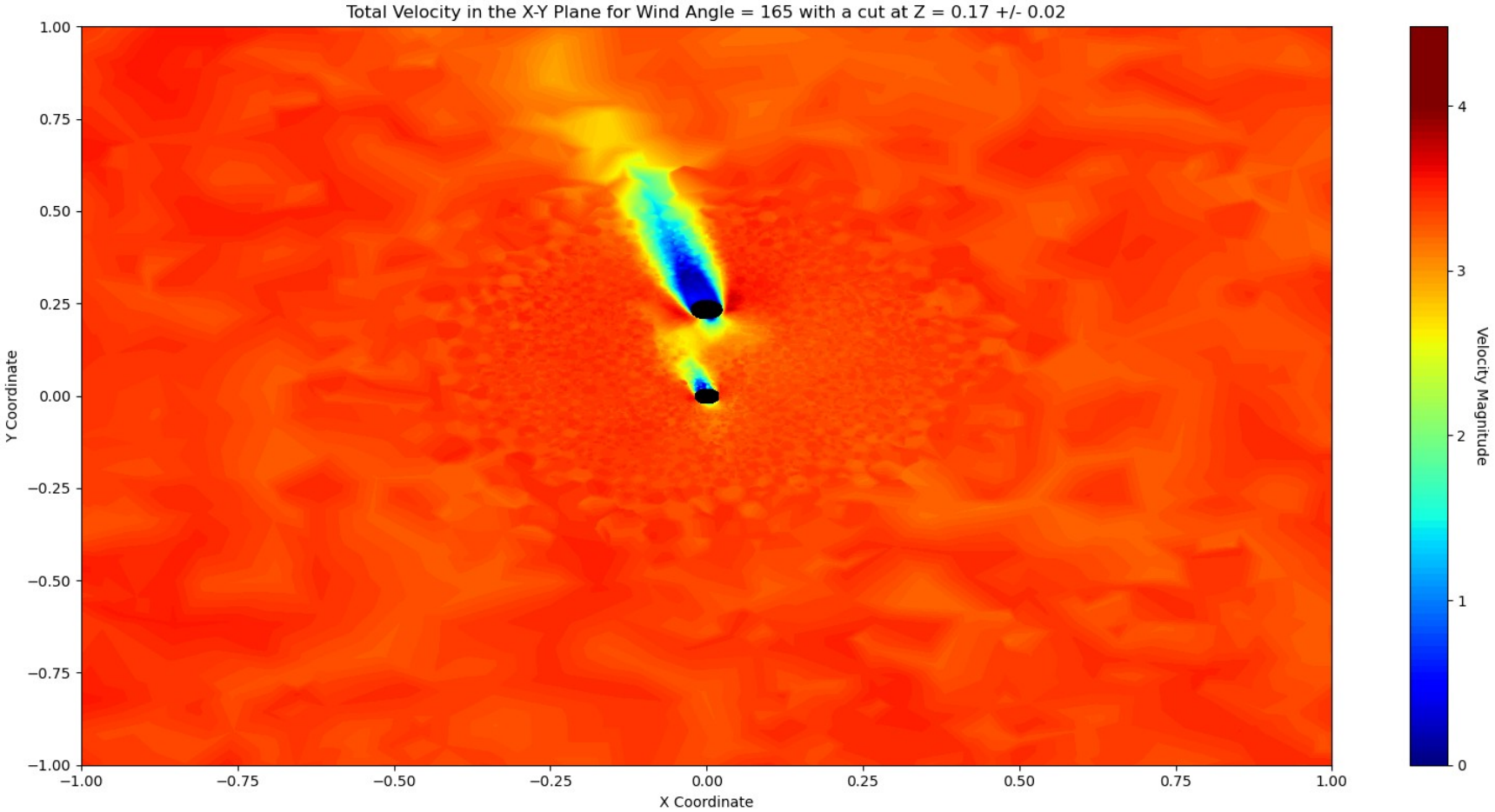

Total Velocity in the X-Y Plane for Wind Angle = 90 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

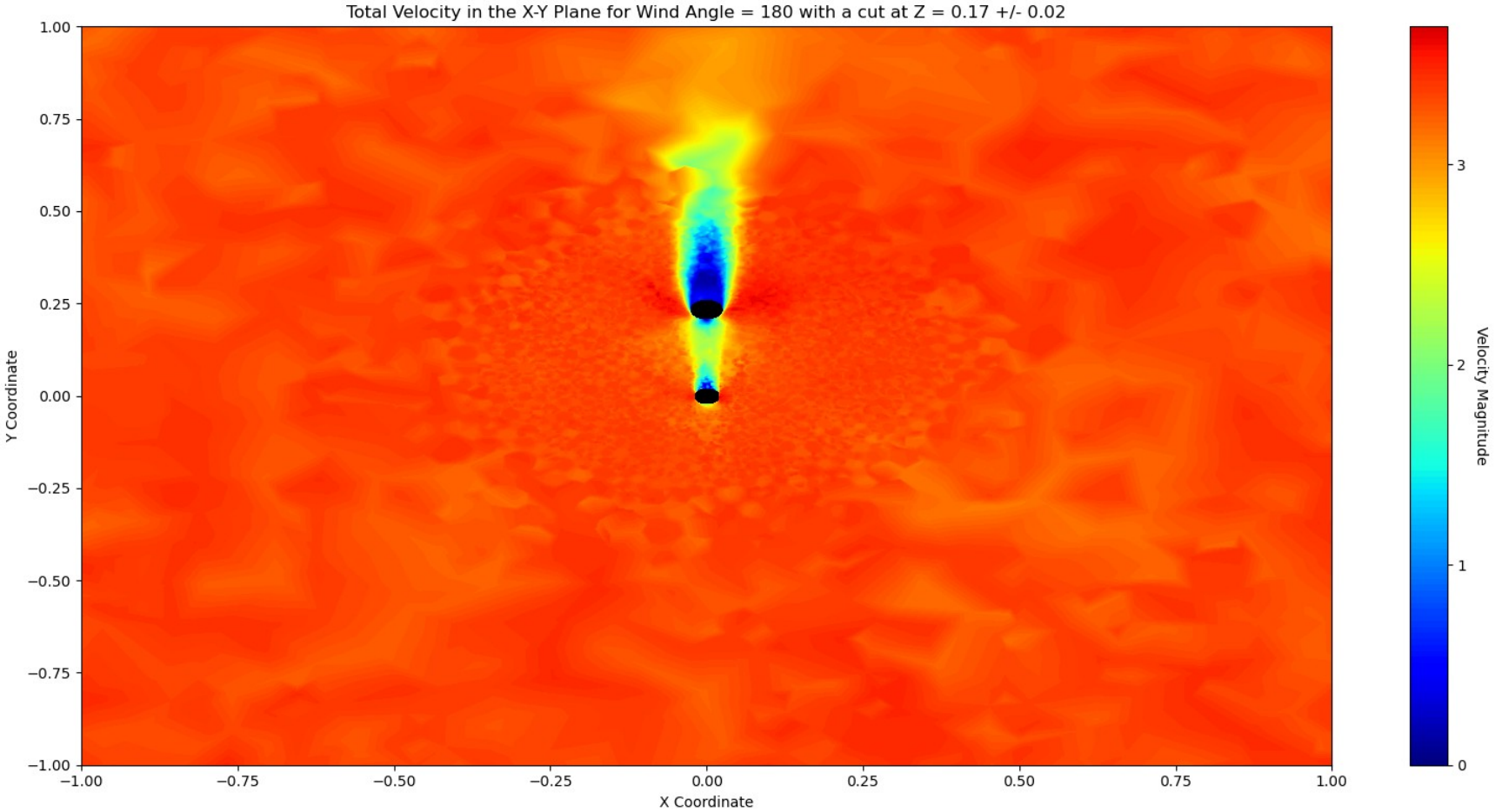

Total Velocity in the X-Y Plane for Wind Angle = 105 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3
4

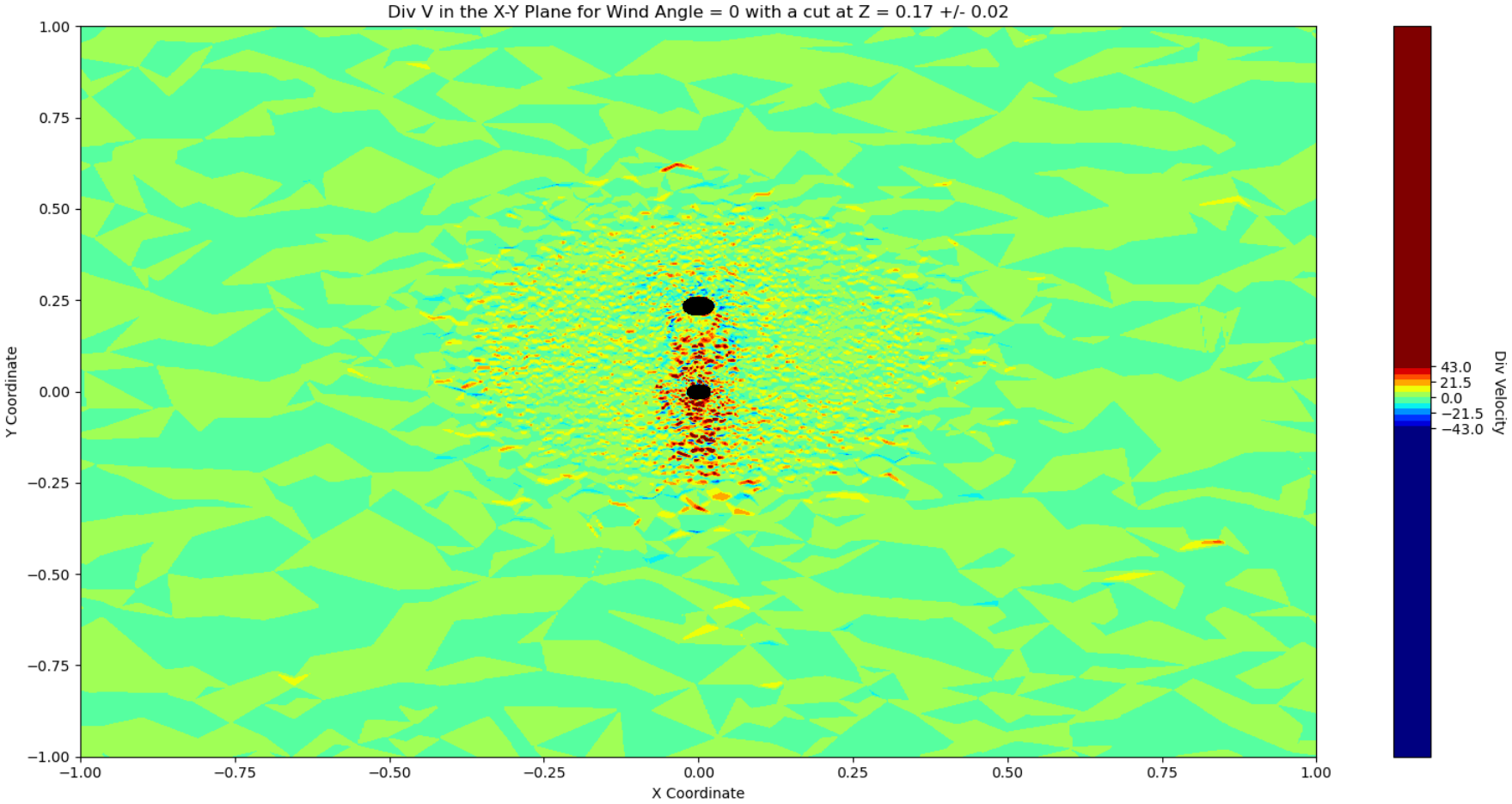

Total Velocity in the X-Y Plane for Wind Angle = 120 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

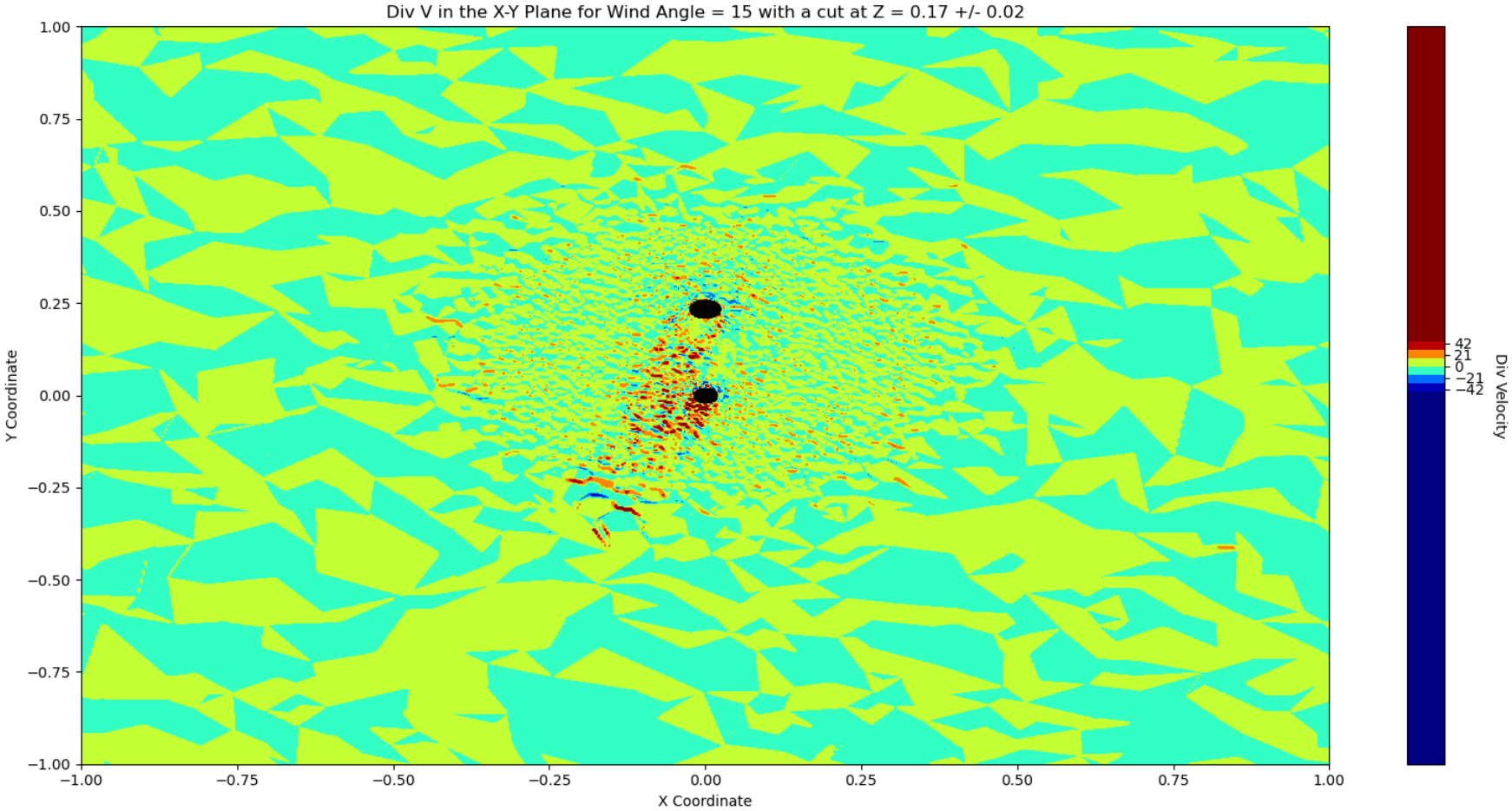

Total Velocity in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

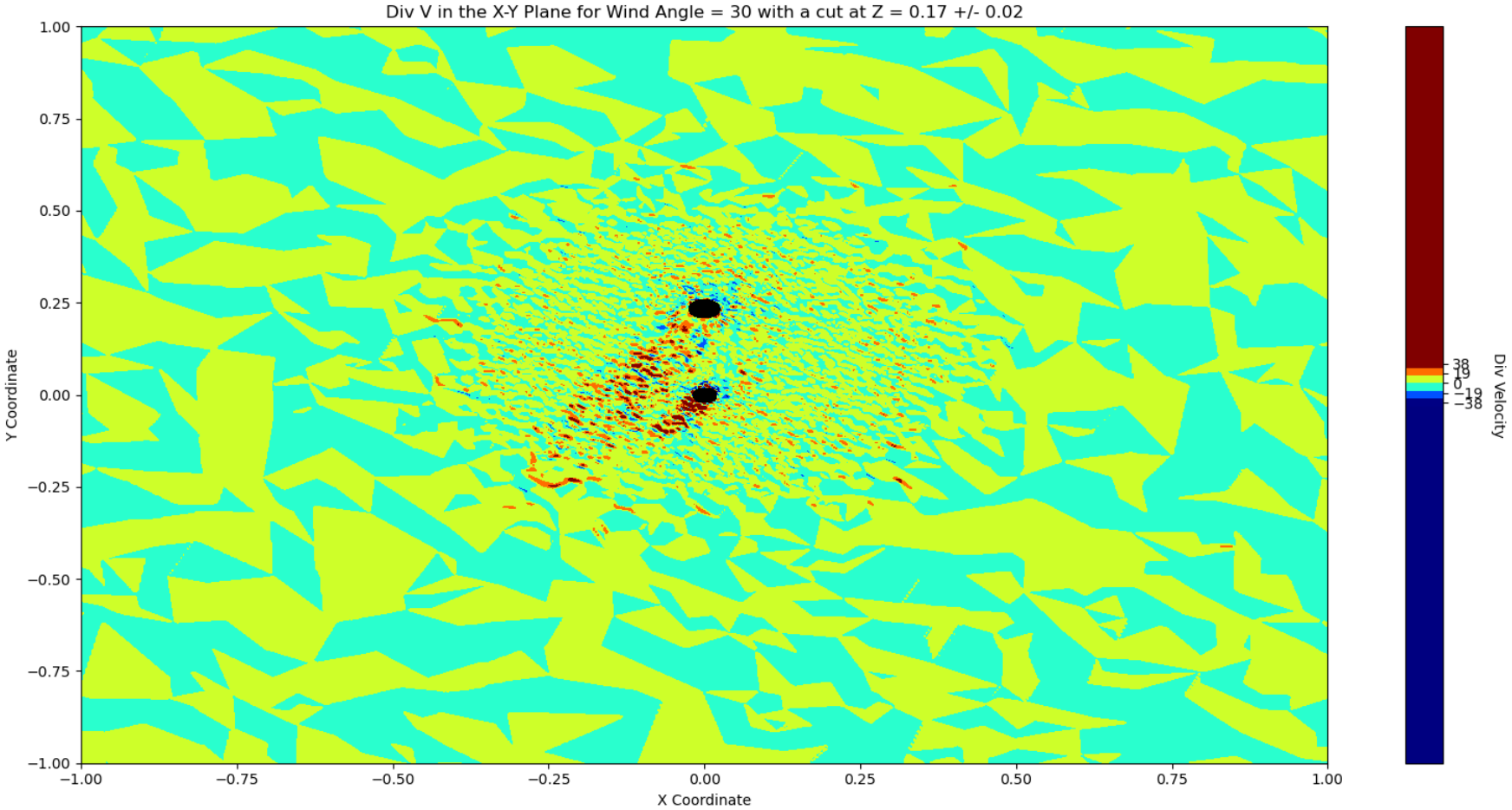

Total Velocity in the X-Y Plane for Wind Angle = 150 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

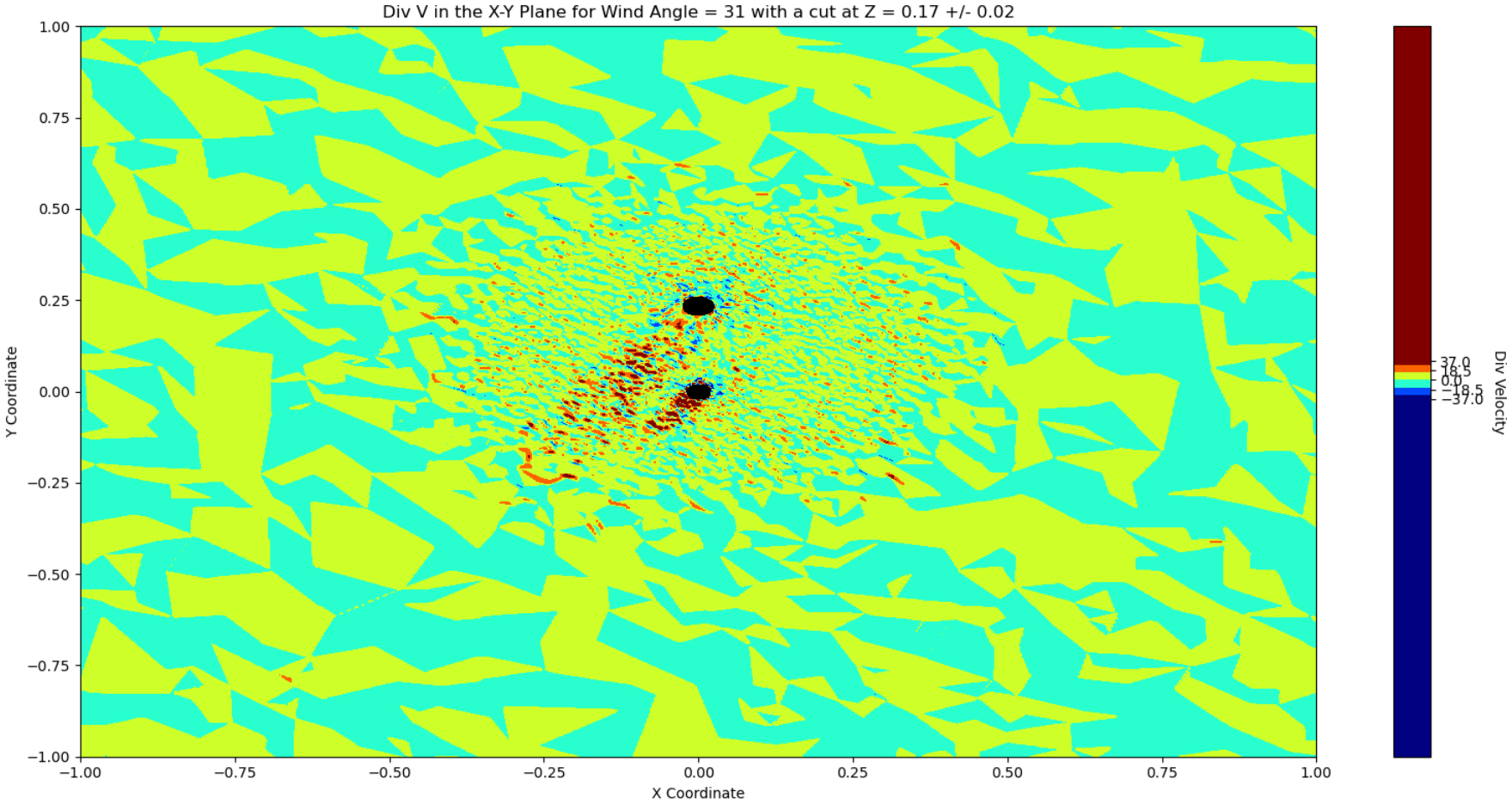

Total Velocity in the X-Y Plane for Wind Angle = 165 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3
4

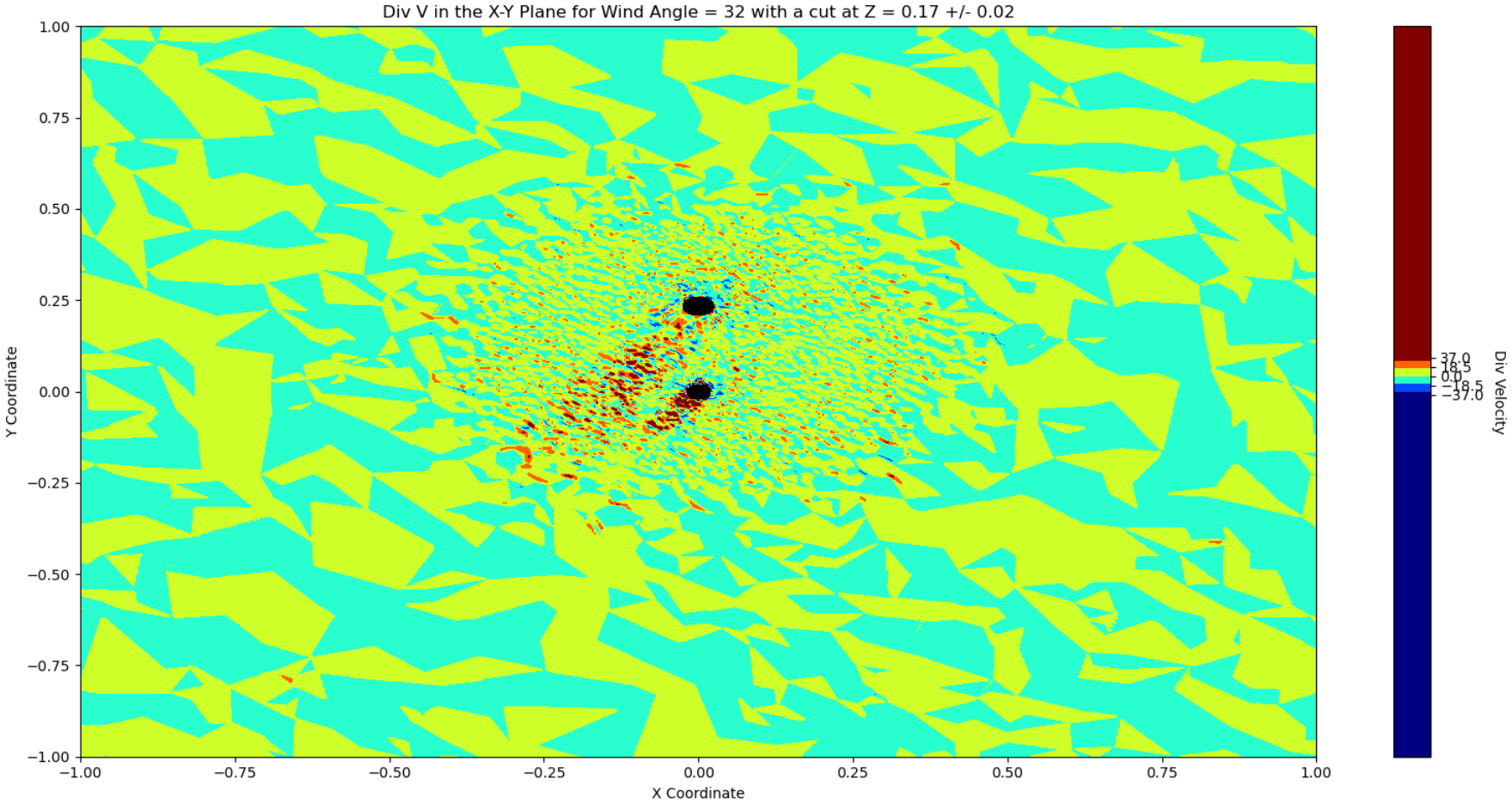

Total Velocity in the X-Y Plane for Wind Angle = 180 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
Velocity Magnitude
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0
1
2
3

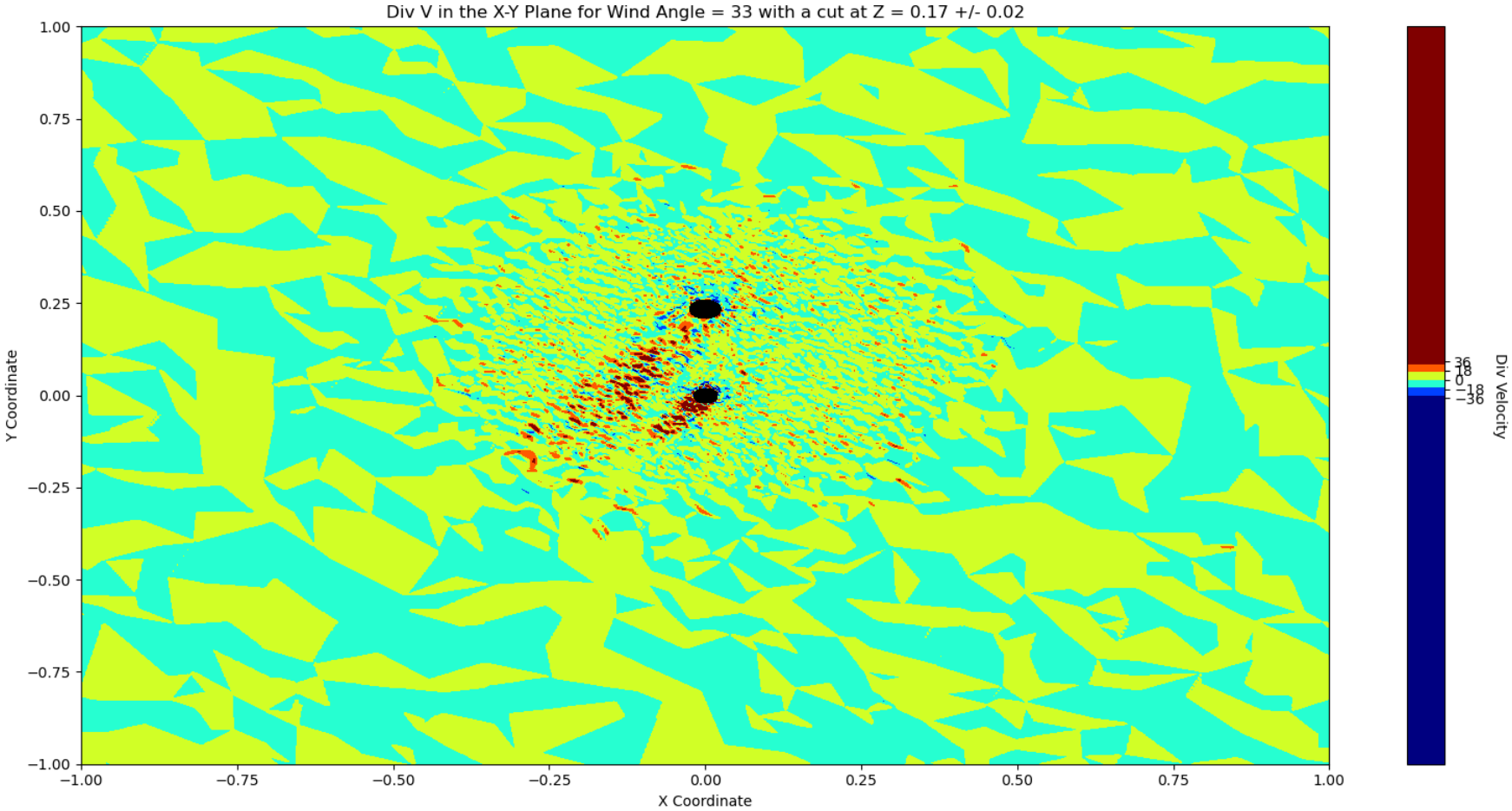

Div V in the X-Y Plane for Wind Angle = 0 with a cut at Z = 0.17 +/- 0.02
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
Y Coordinate
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
X Coordinate
43.0
21.5
0.0
−21.5
−43.0
Div Velocity

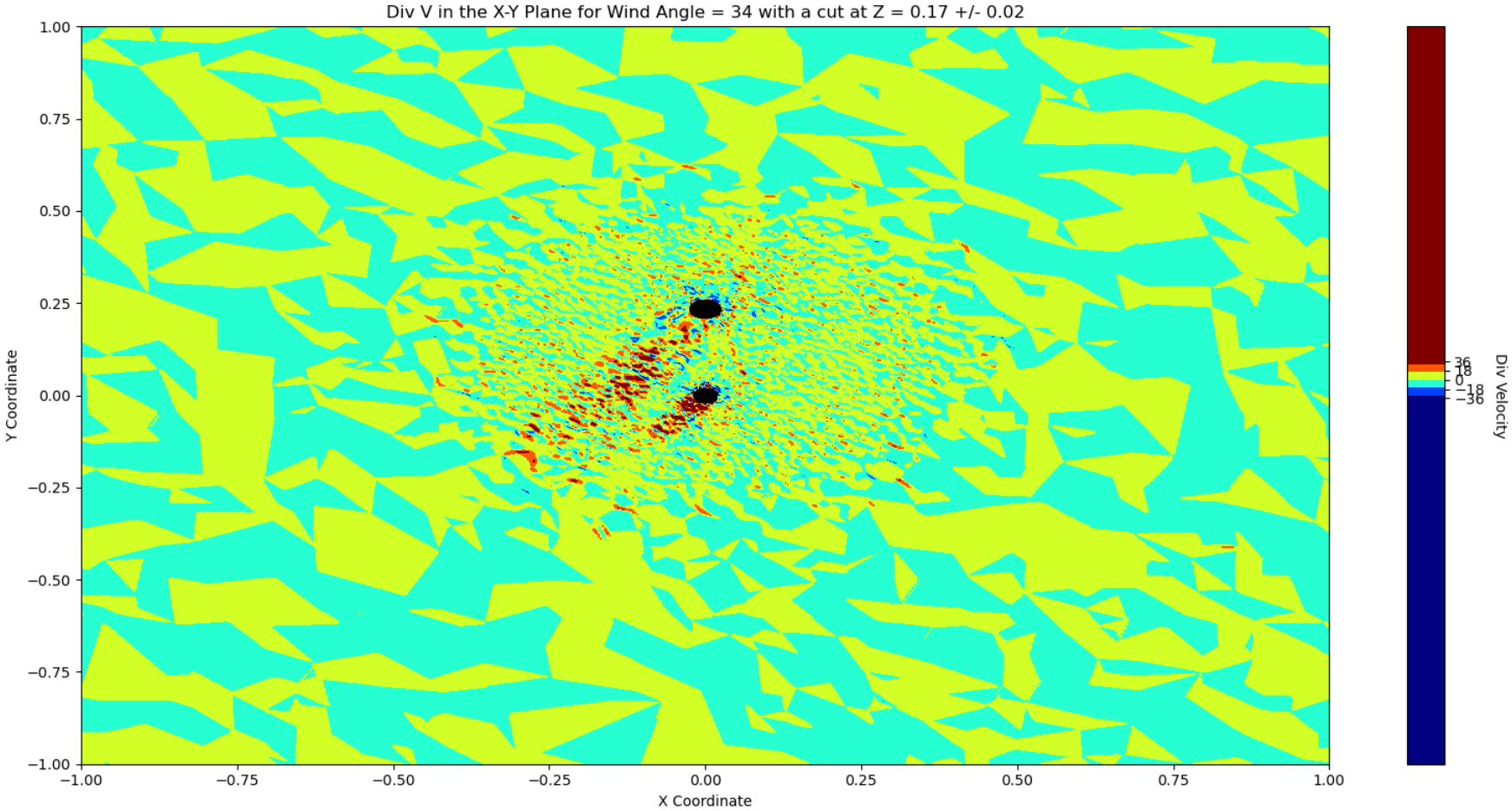

Div V in the X-Y Plane for Wind Angle = 15 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
42
21
0
−21
−42
Div Velocity

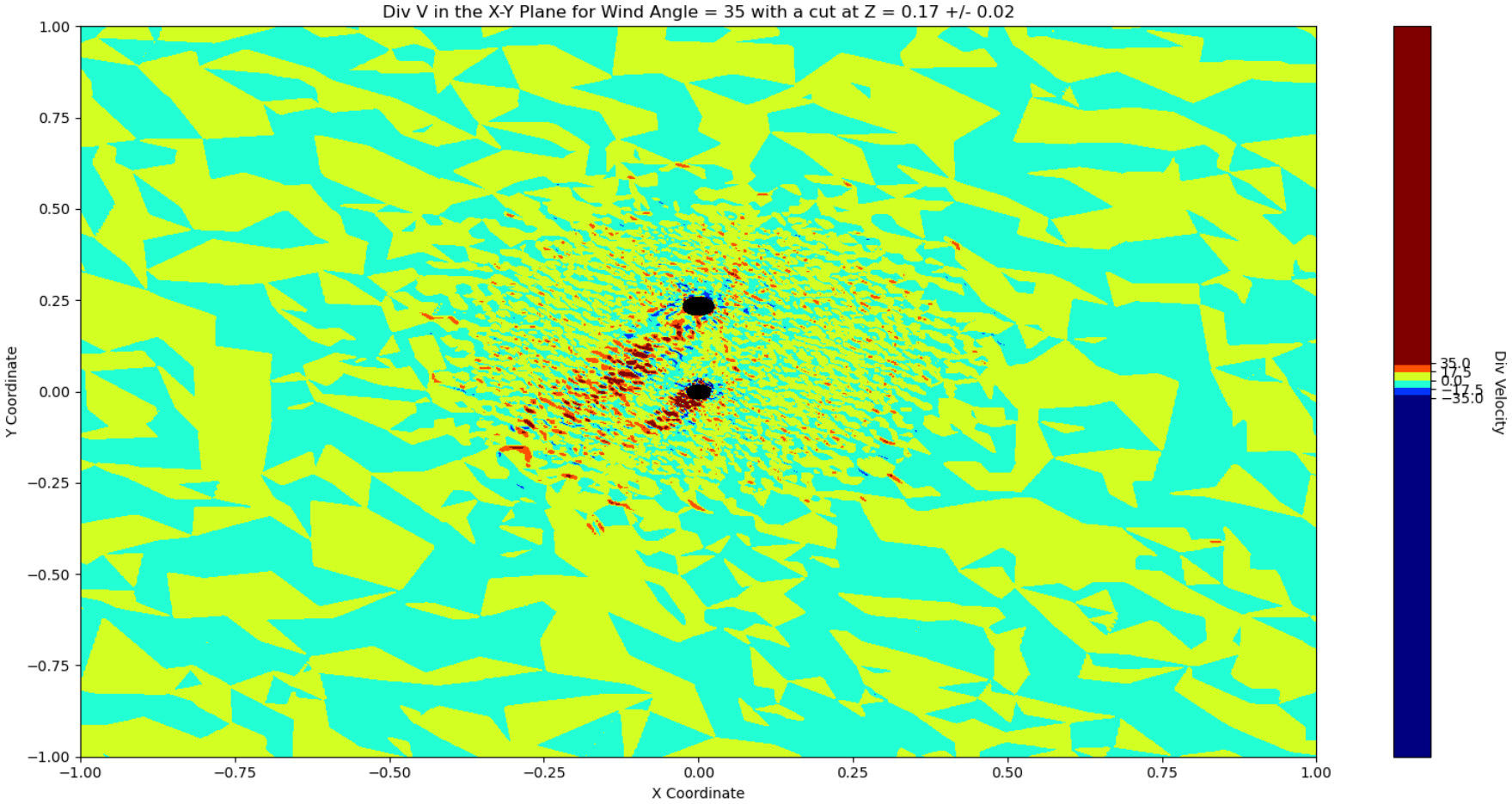

Div V in the X-Y Plane for Wind Angle = 30 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
Div Velocity
38
19
0
−19
−38

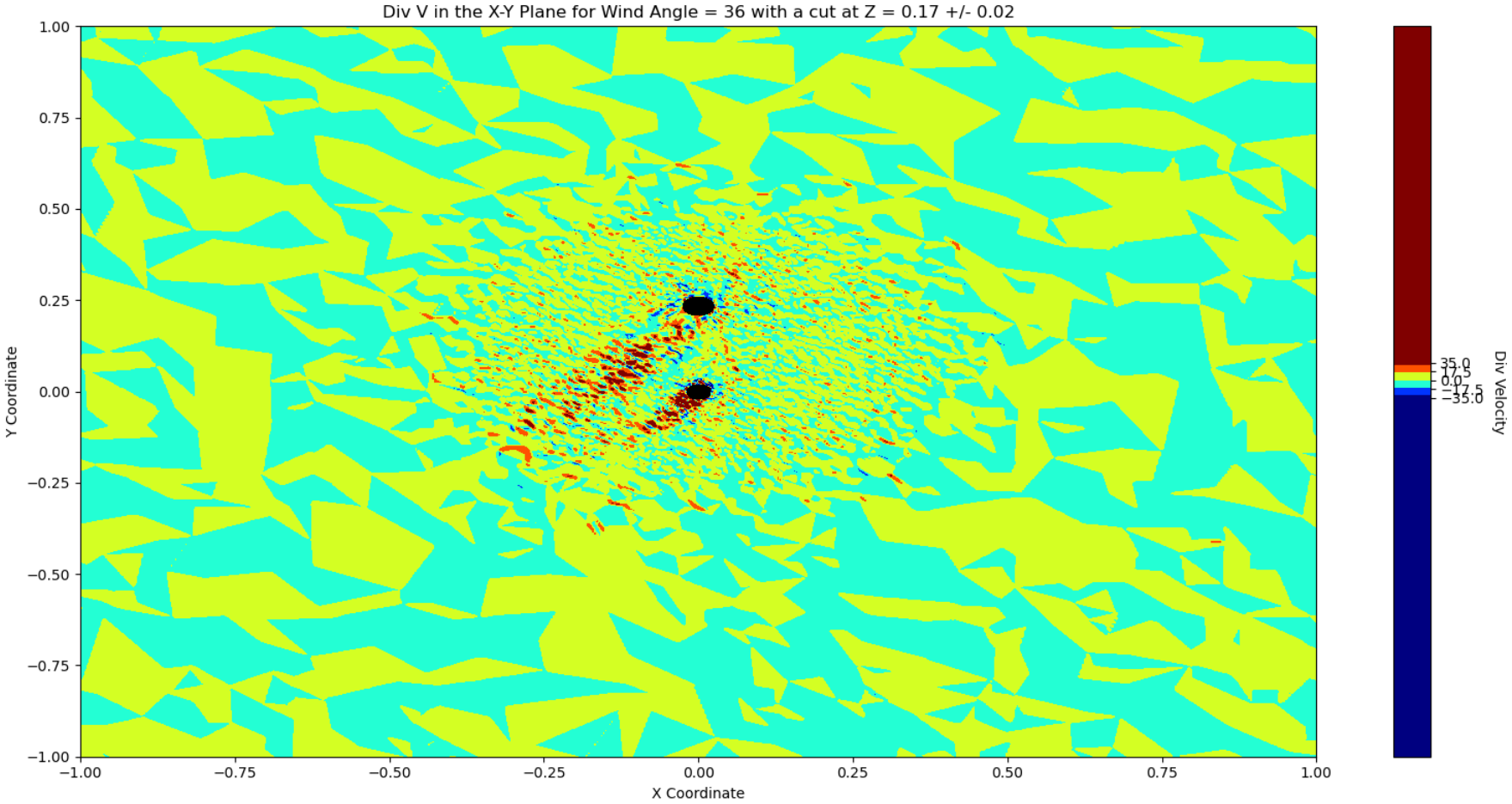

Div V in the X-Y Plane for Wind Angle = 31 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
37.0
18.5
0.0
−18.5
−37.0

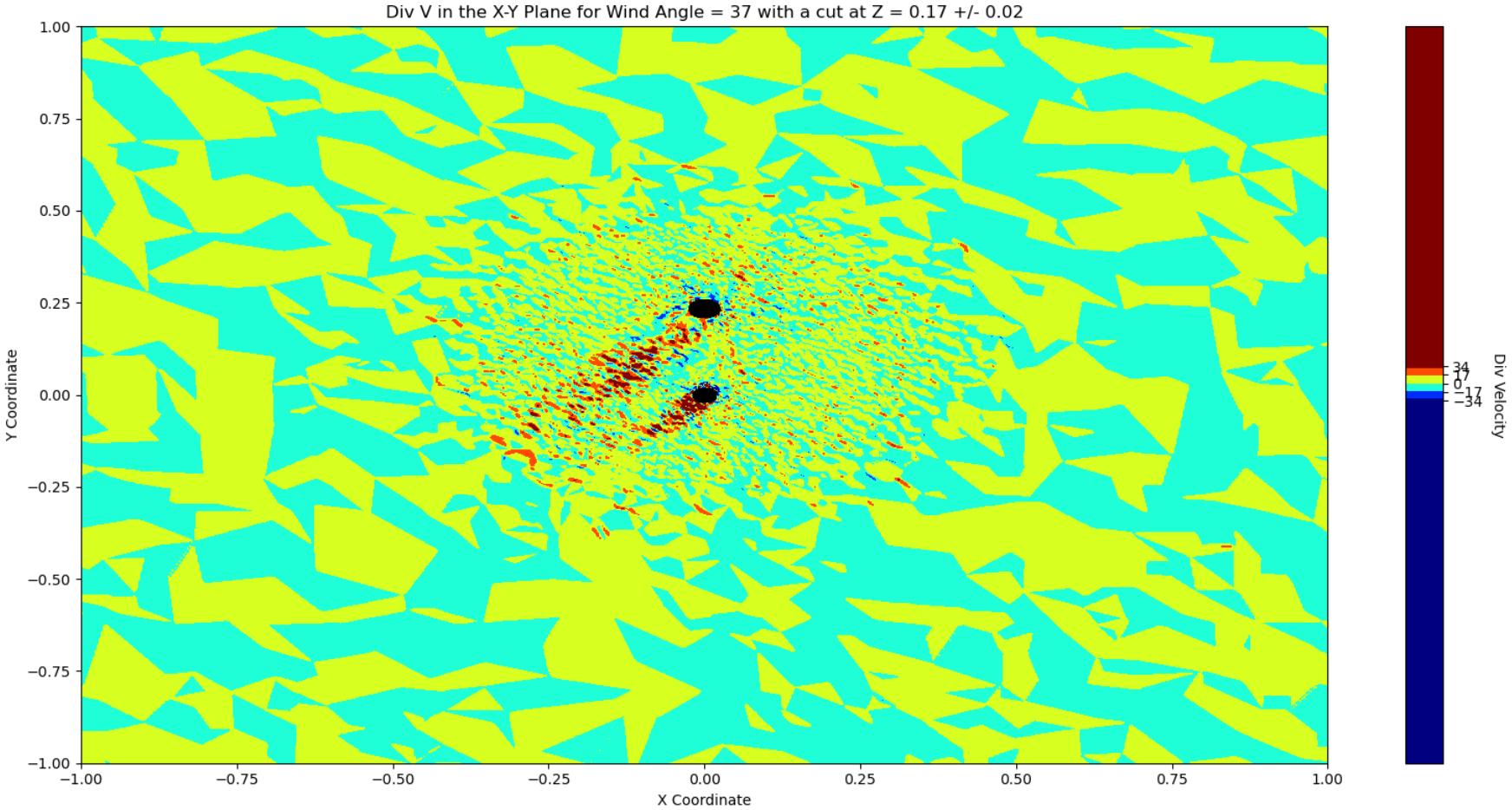

Div V in the X-Y Plane for Wind Angle = 32 with a cut at Z = 0.17 +/- 0.02
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
Y Coordinate
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
X Coordinate
37.0
18.5
0.0
−18.5
−37.0
Div Velocity

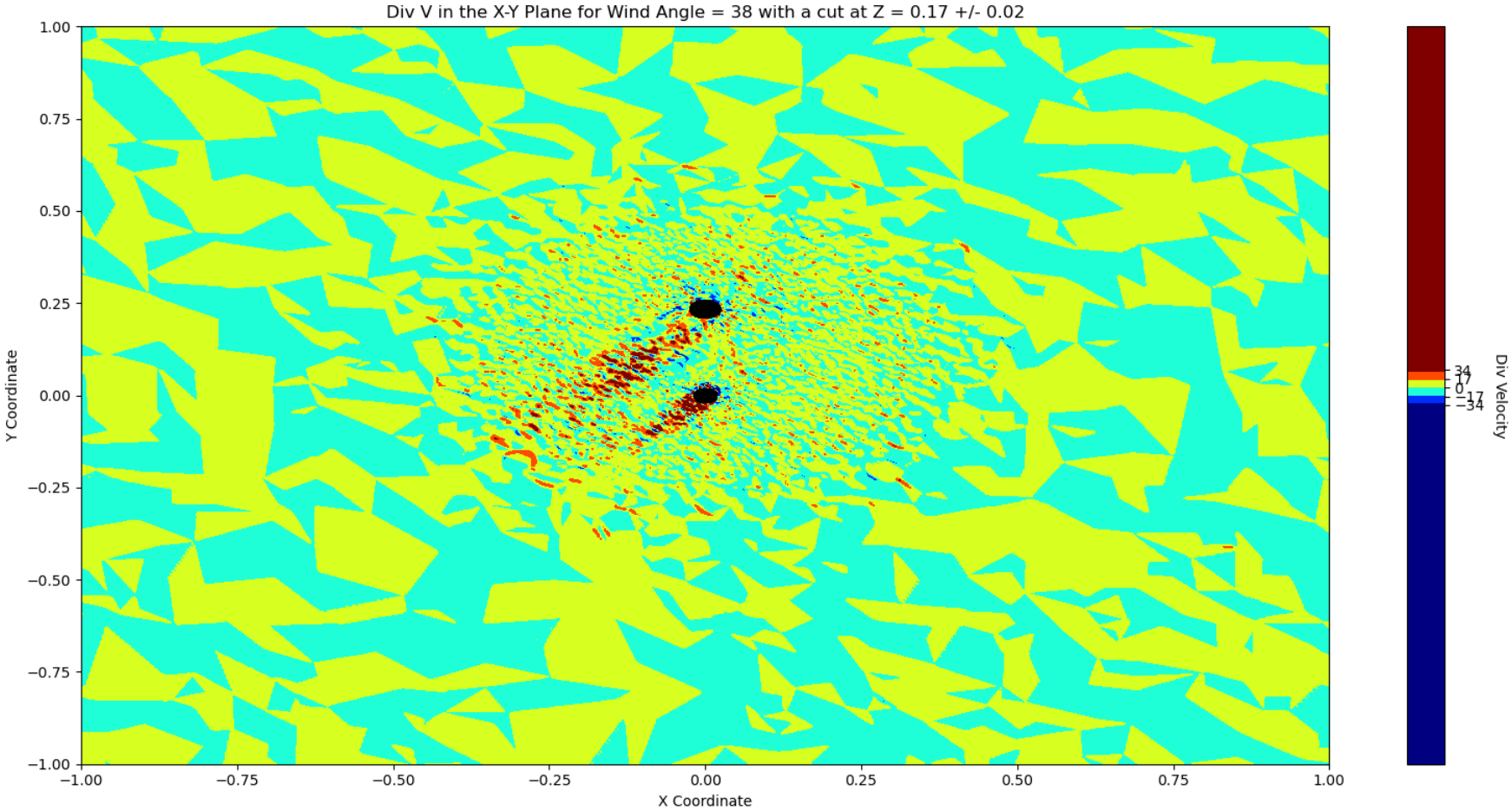

Div V in the X-Y Plane for Wind Angle = 33 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
36
18
0
−18
−36

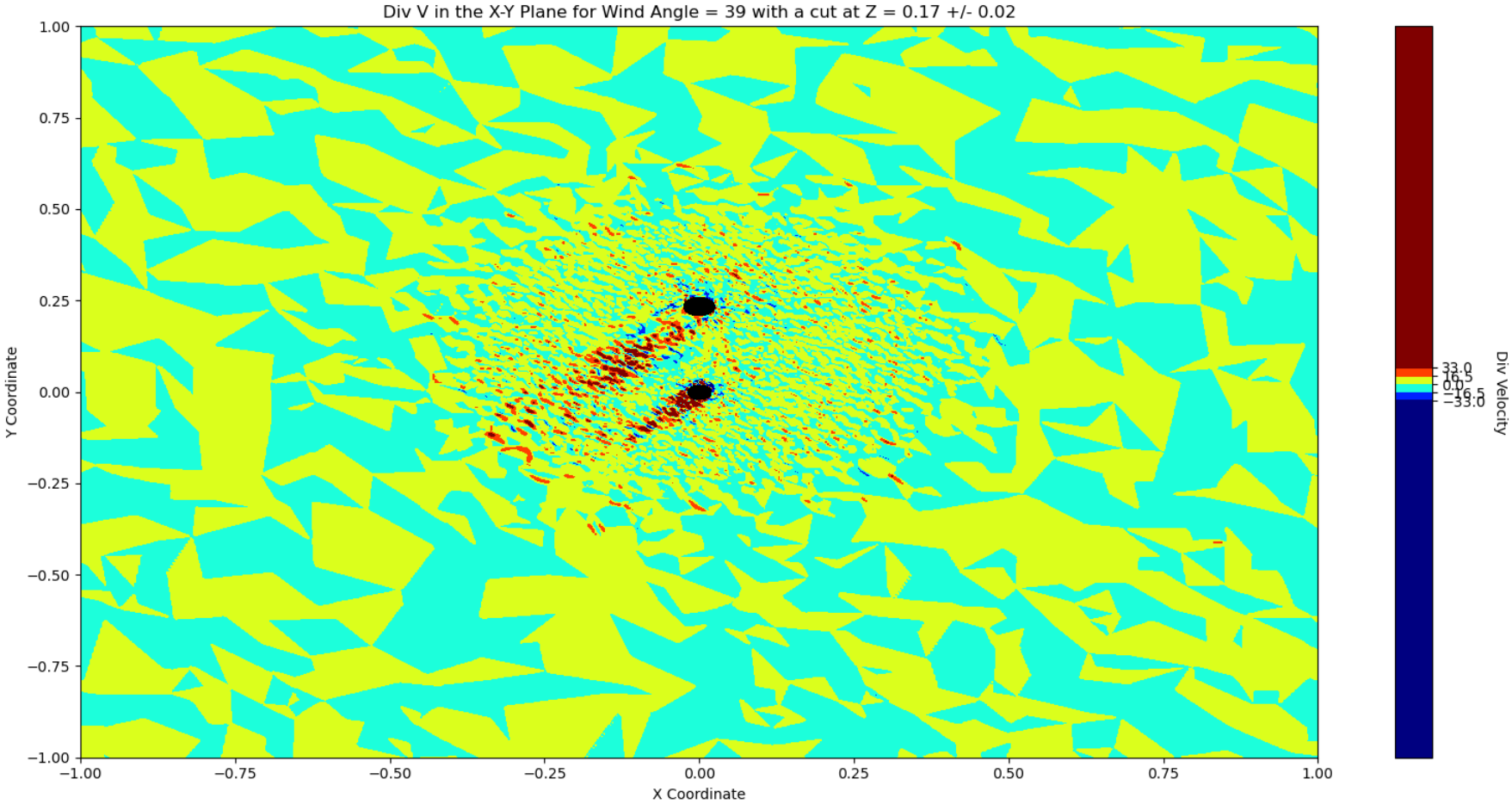

Div V in the X-Y Plane for Wind Angle = 34 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
36
18
0
−18
−36

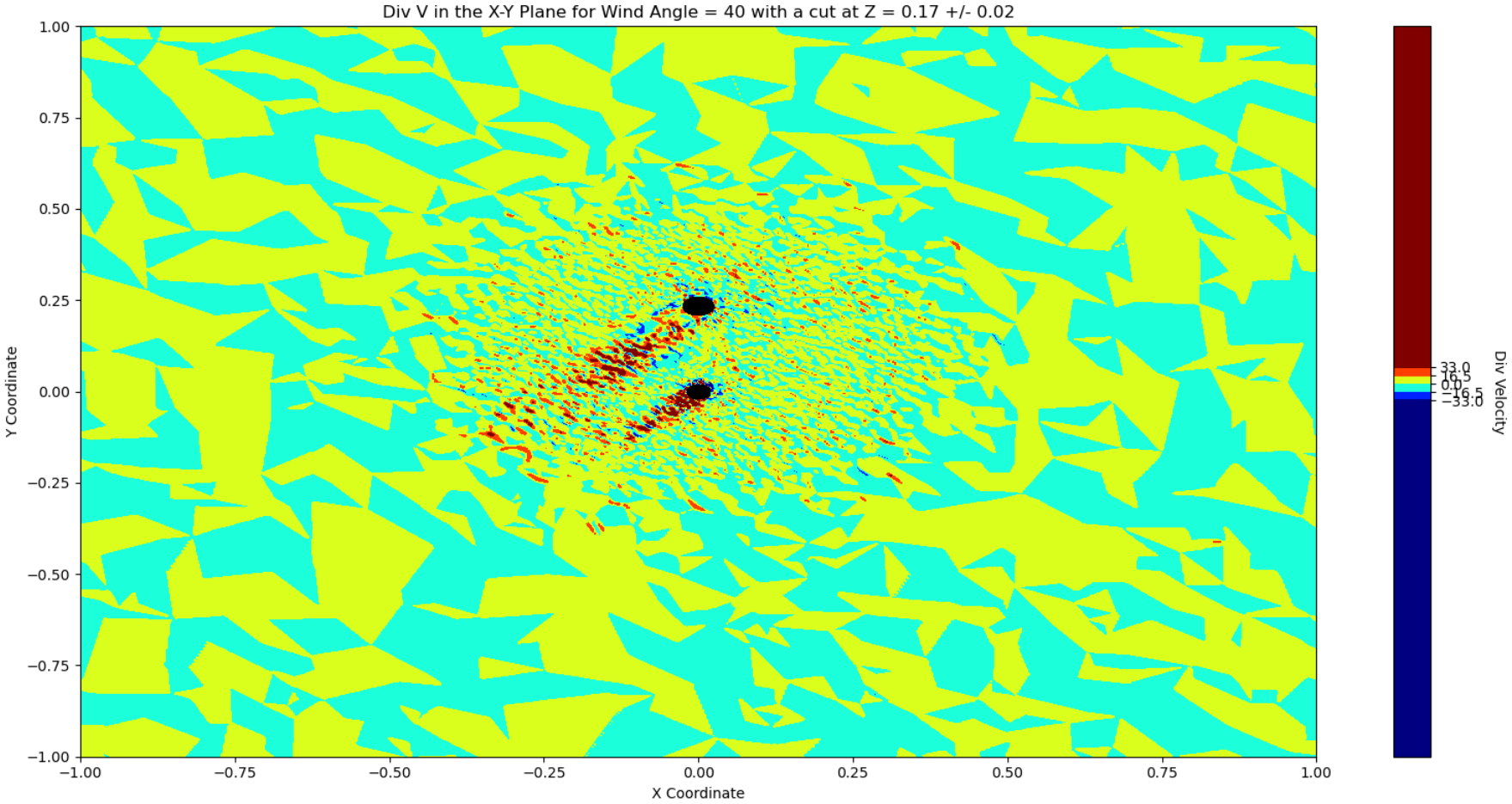

Div V in the X-Y Plane for Wind Angle = 35 with a cut at Z = 0.17 +/- 0.02
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
Y Coordinate
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
X Coordinate
35.0
17.5
0.0
−17.5
−35.0
Div Velocity

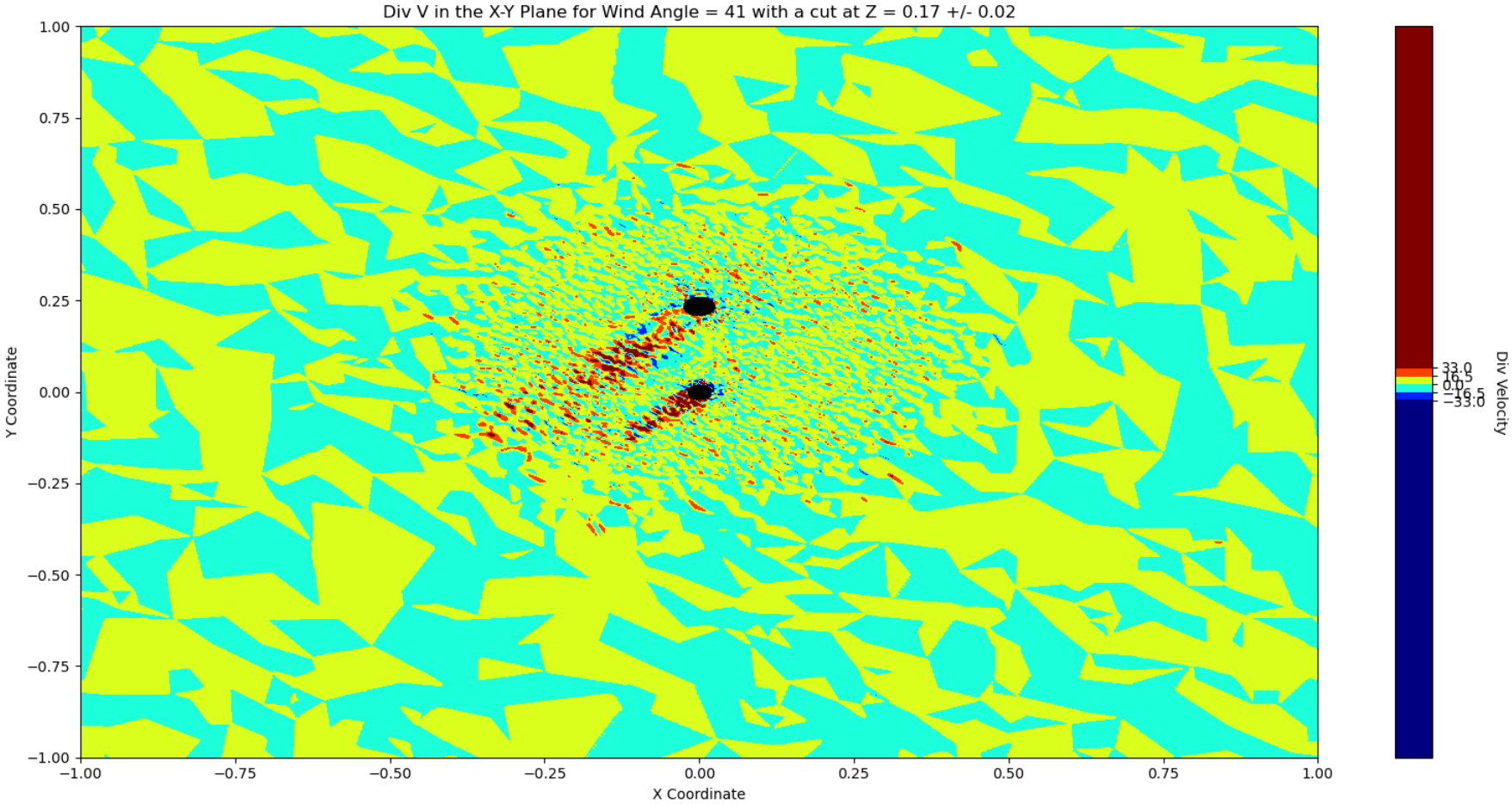

Div V in the X-Y Plane for Wind Angle = 36 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
35.0
17.5
0.0
−17.5
−35.0

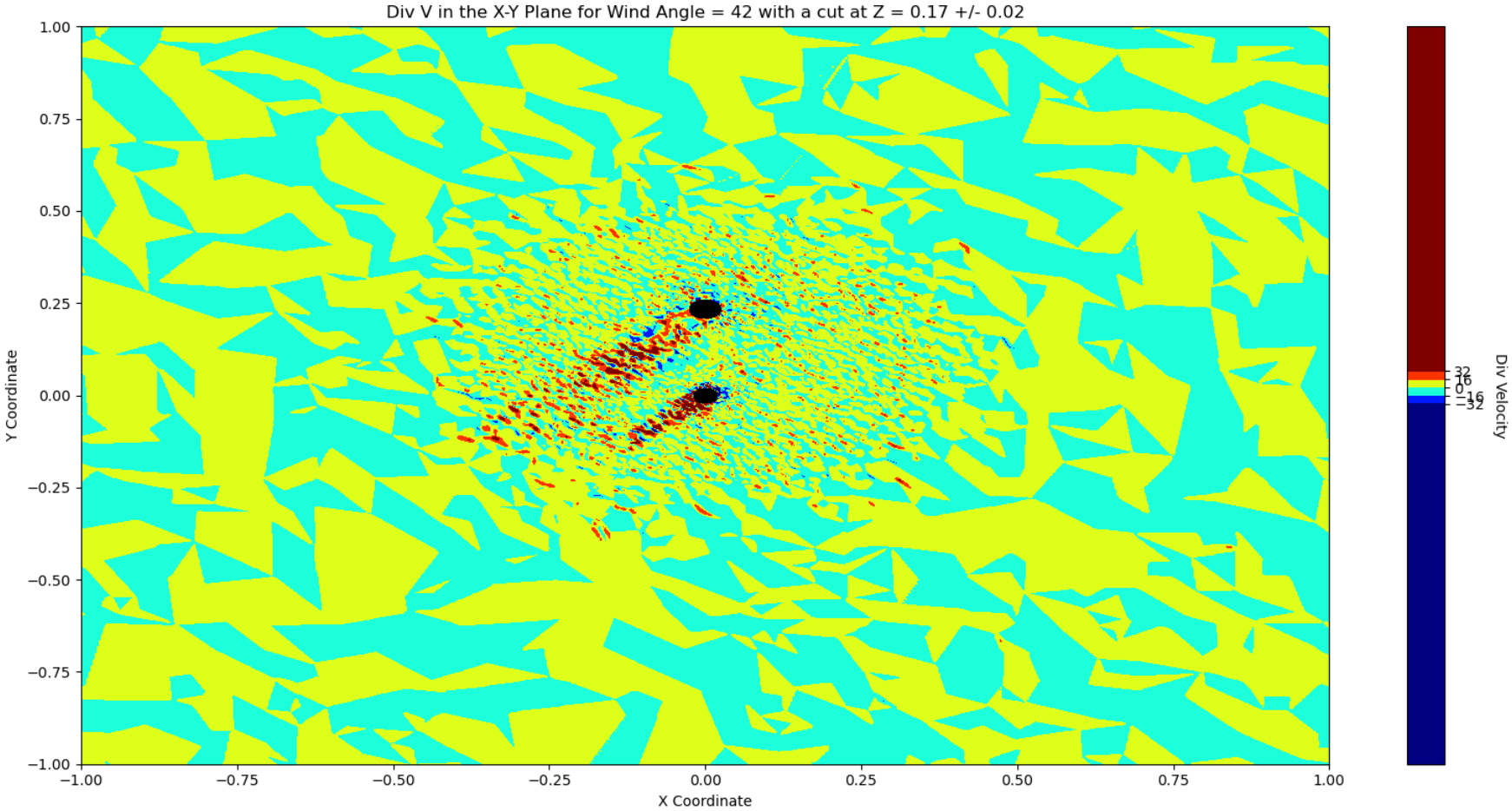

Div V in the X-Y Plane for Wind Angle = 37 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
34
17
0
−17
−34

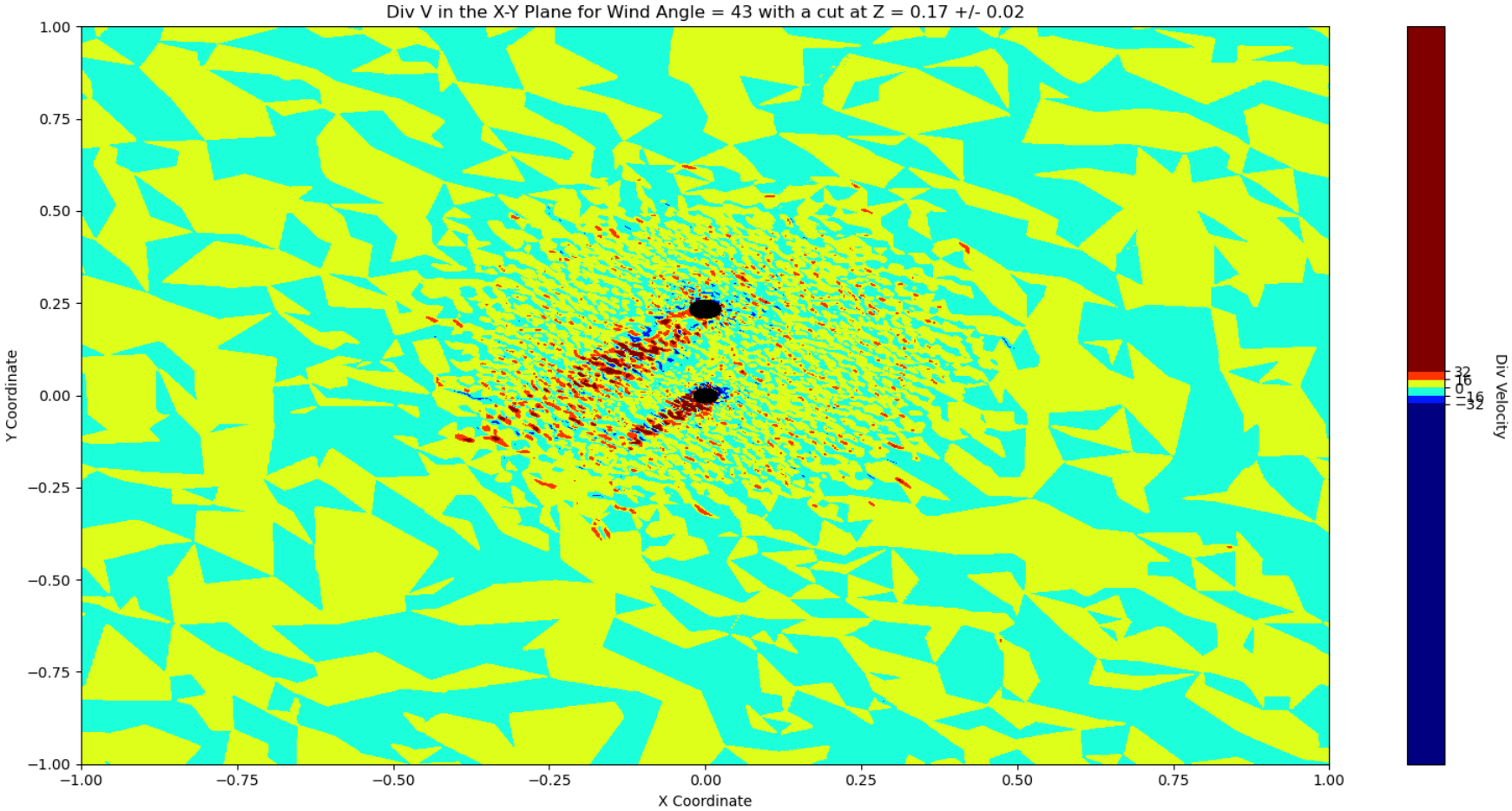

Div V in the X-Y Plane for Wind Angle = 38 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
Div Velocity
34
17
0
−17
−34

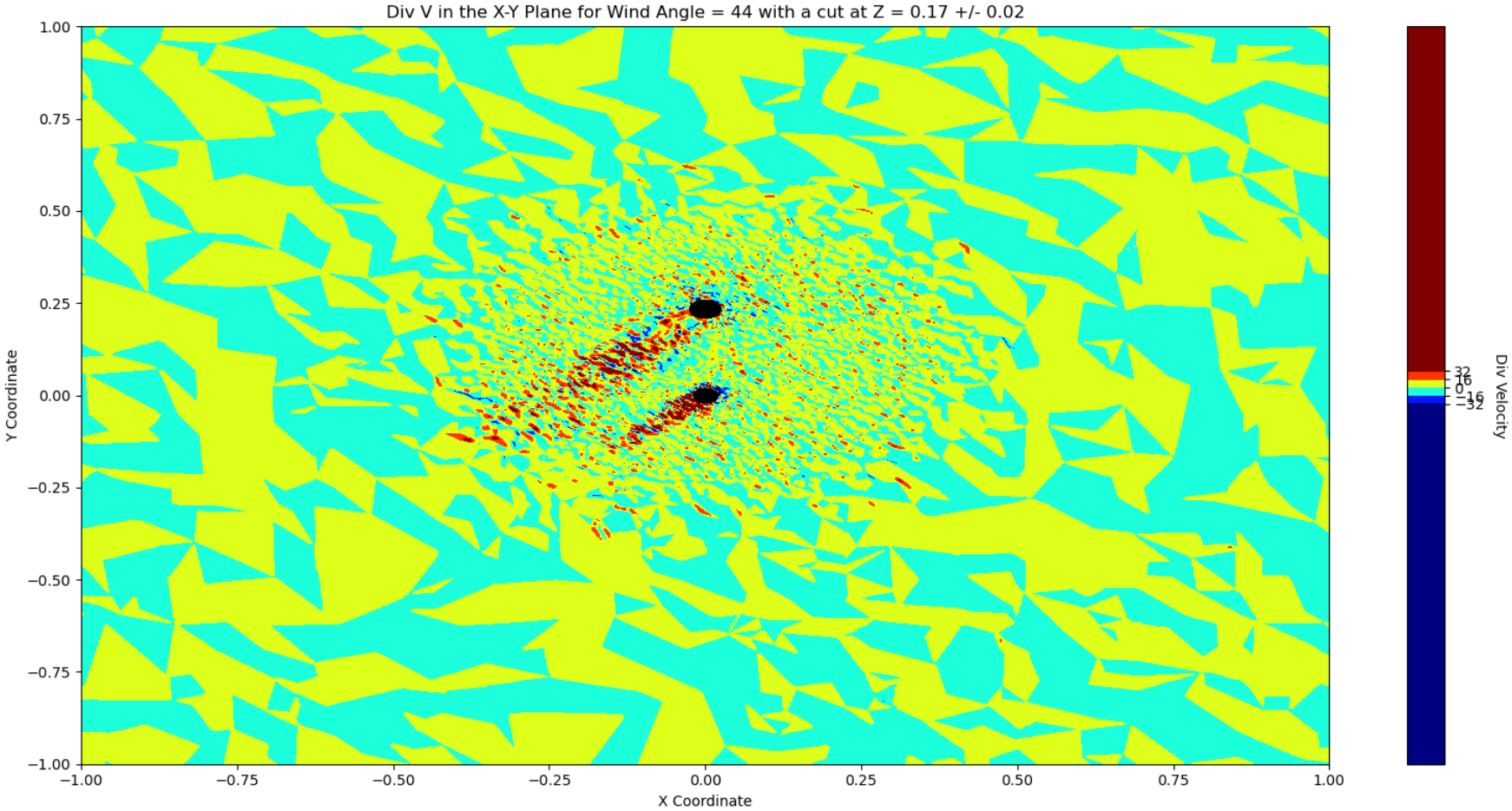

Div V in the X-Y Plane for Wind Angle = 39 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
33.0
16.5
0.0
−16.5
−33.0

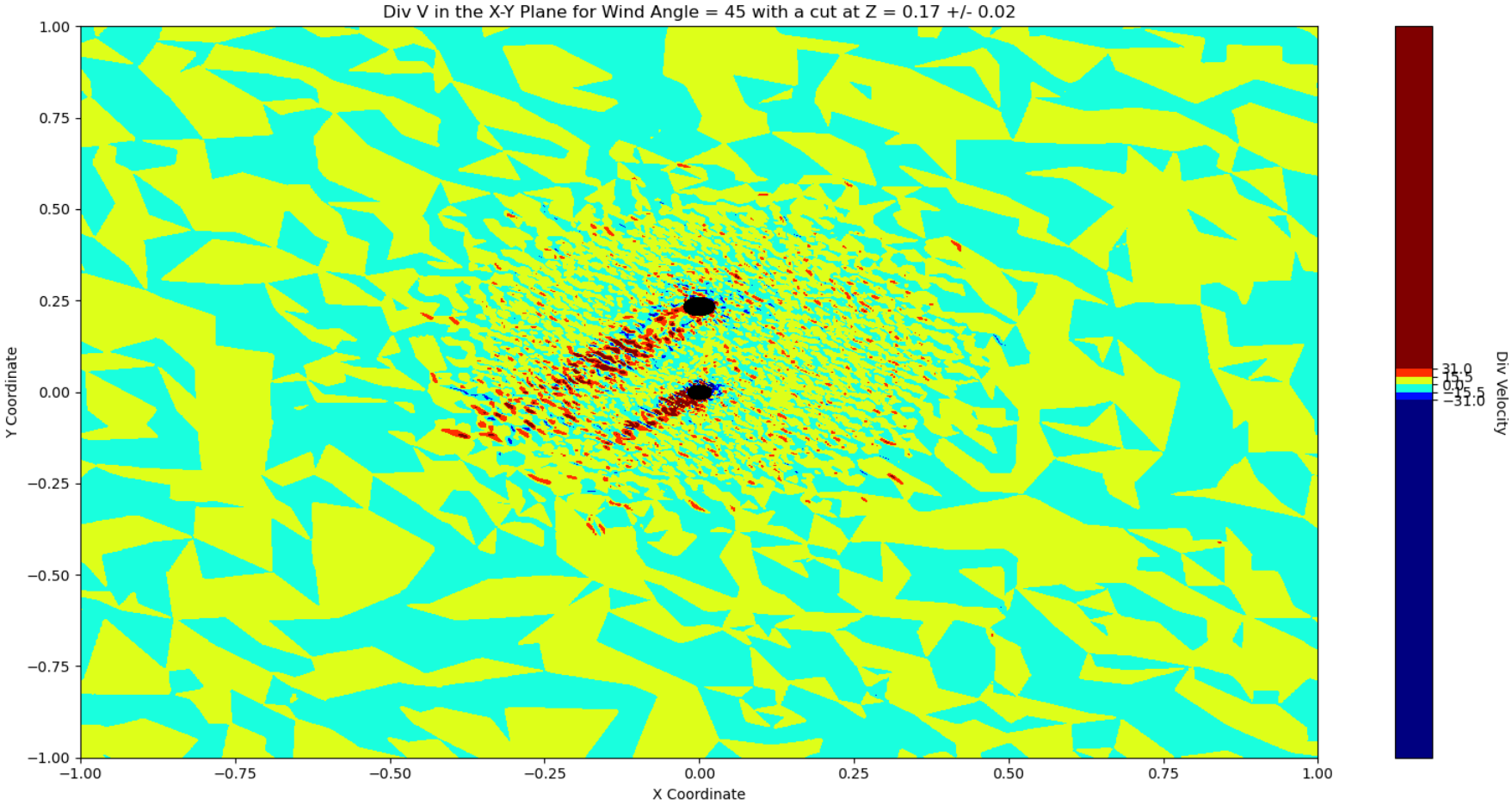

Div V in the X-Y Plane for Wind Angle = 40 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
33.0
16.5
0.0
−16.5
−33.0

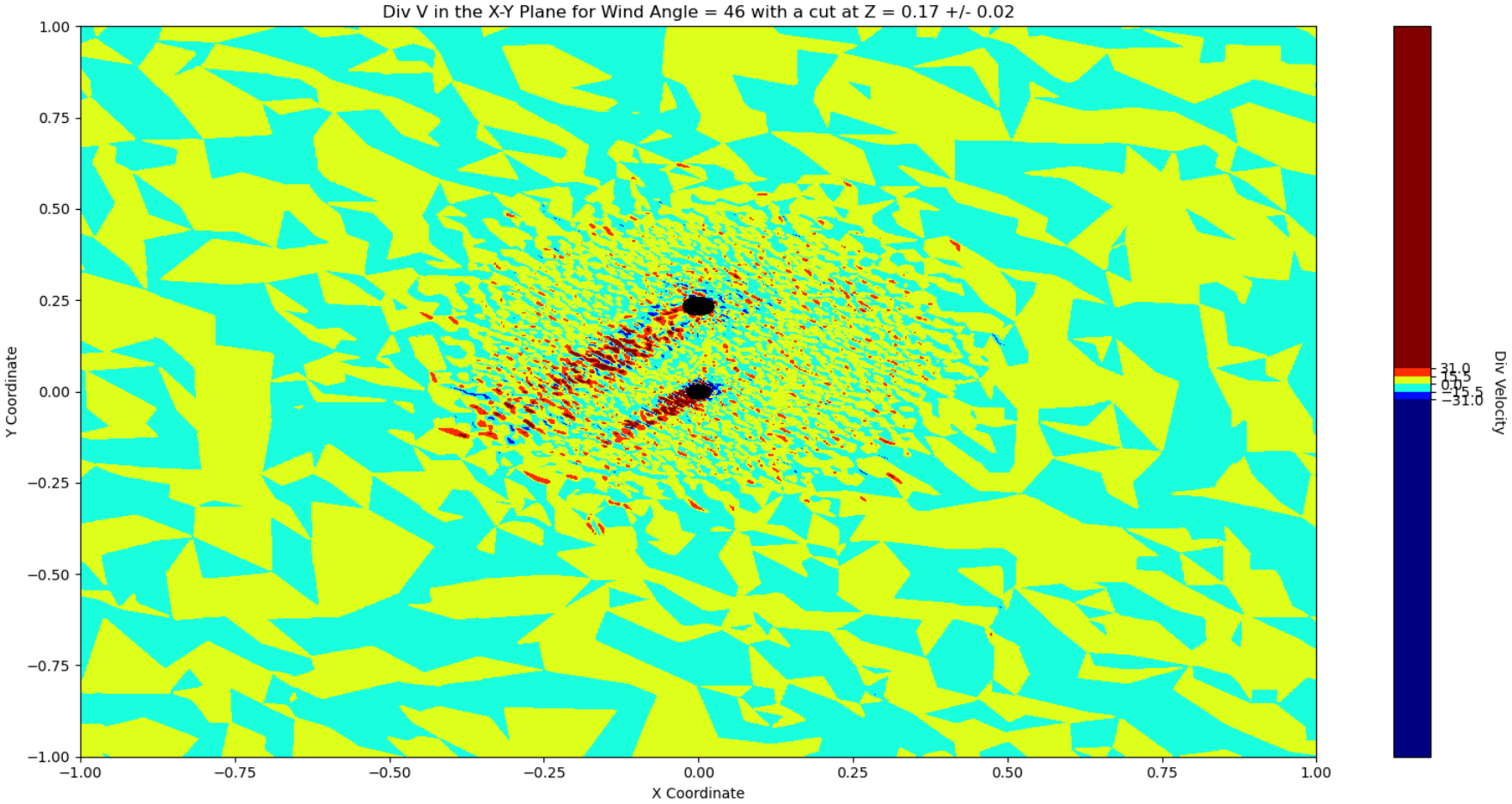

Div V in the X-Y Plane for Wind Angle = 41 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
33.0
16.5
0.0
−16.5
−33.0

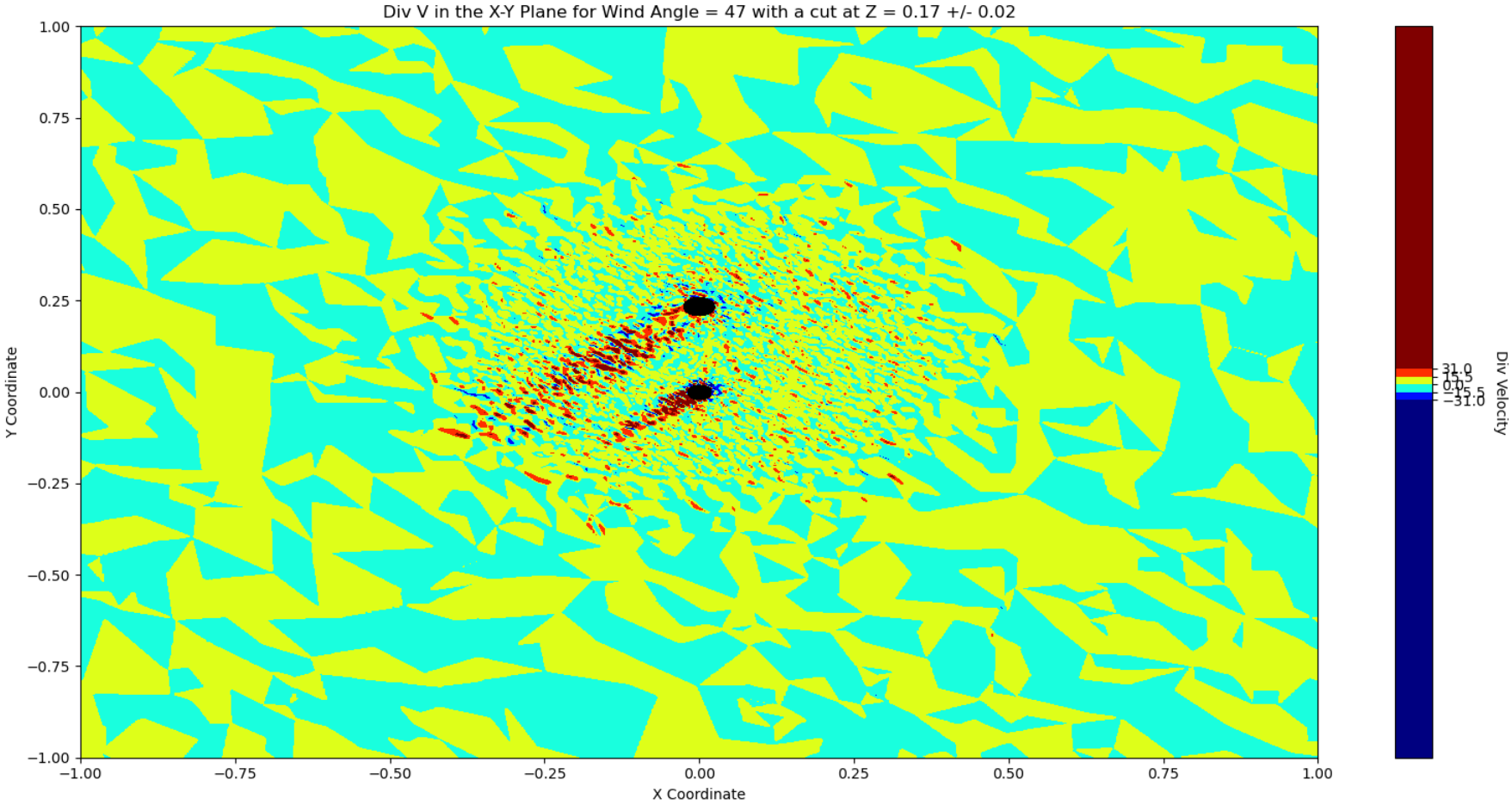

Div V in the X-Y Plane for Wind Angle = 42 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
32
16
0
−16
−32

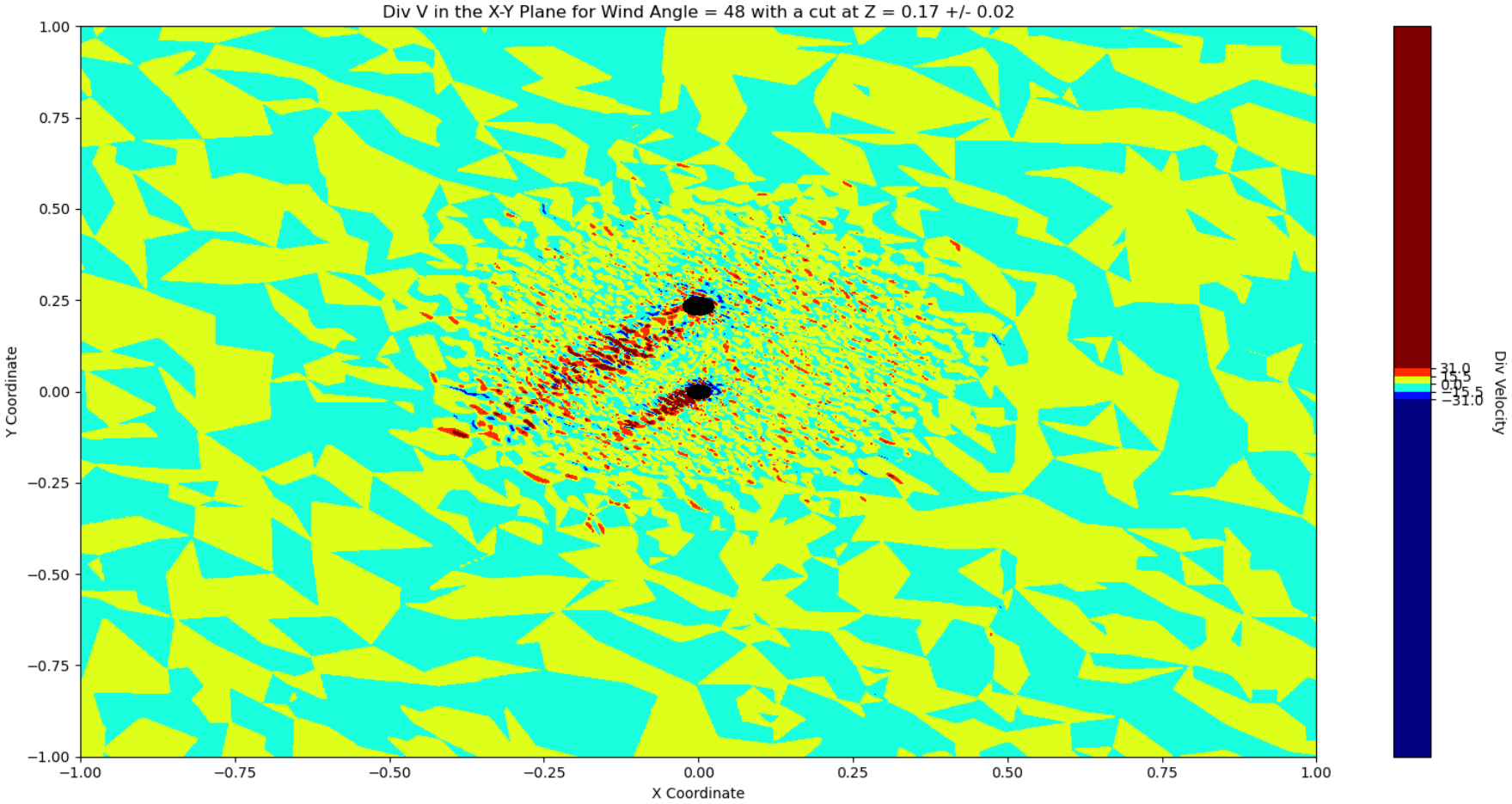

Div V in the X-Y Plane for Wind Angle = 43 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
32
16
0
−16
−32

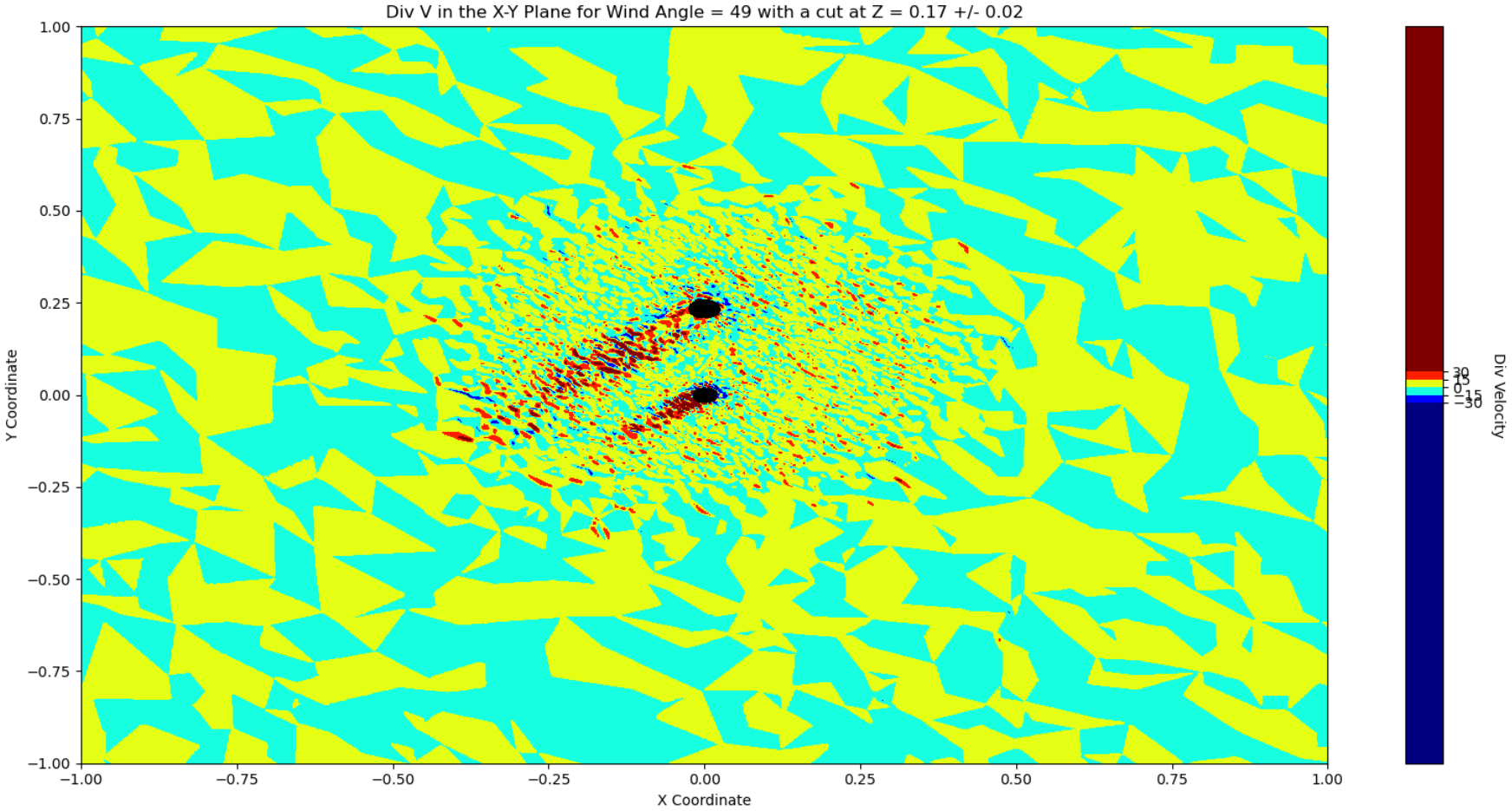

Div V in the X-Y Plane for Wind Angle = 44 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
32
16
0
−16
−32

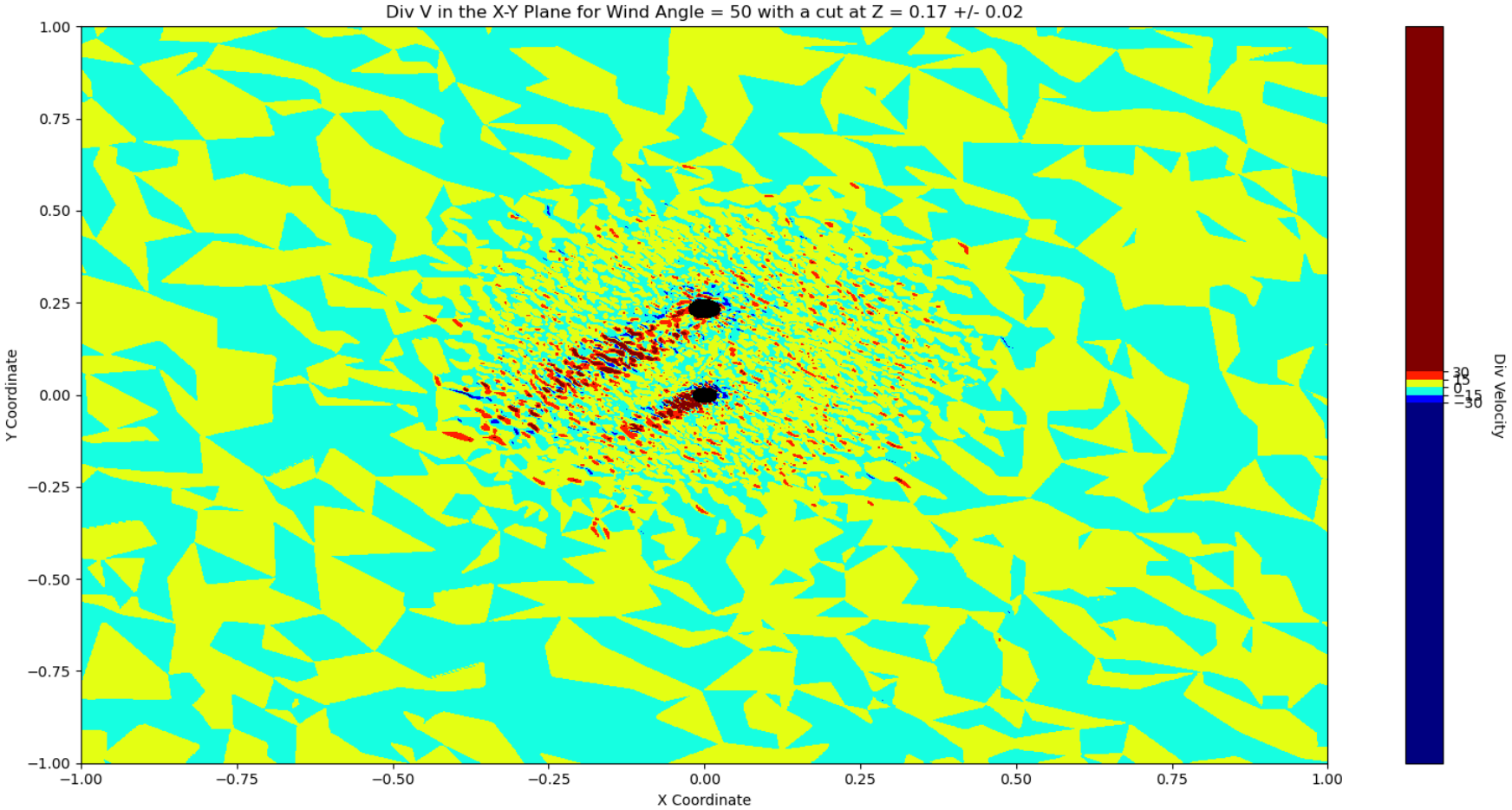

Div V in the X-Y Plane for Wind Angle = 45 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
31.0
15.5
0.0
−15.5
−31.0

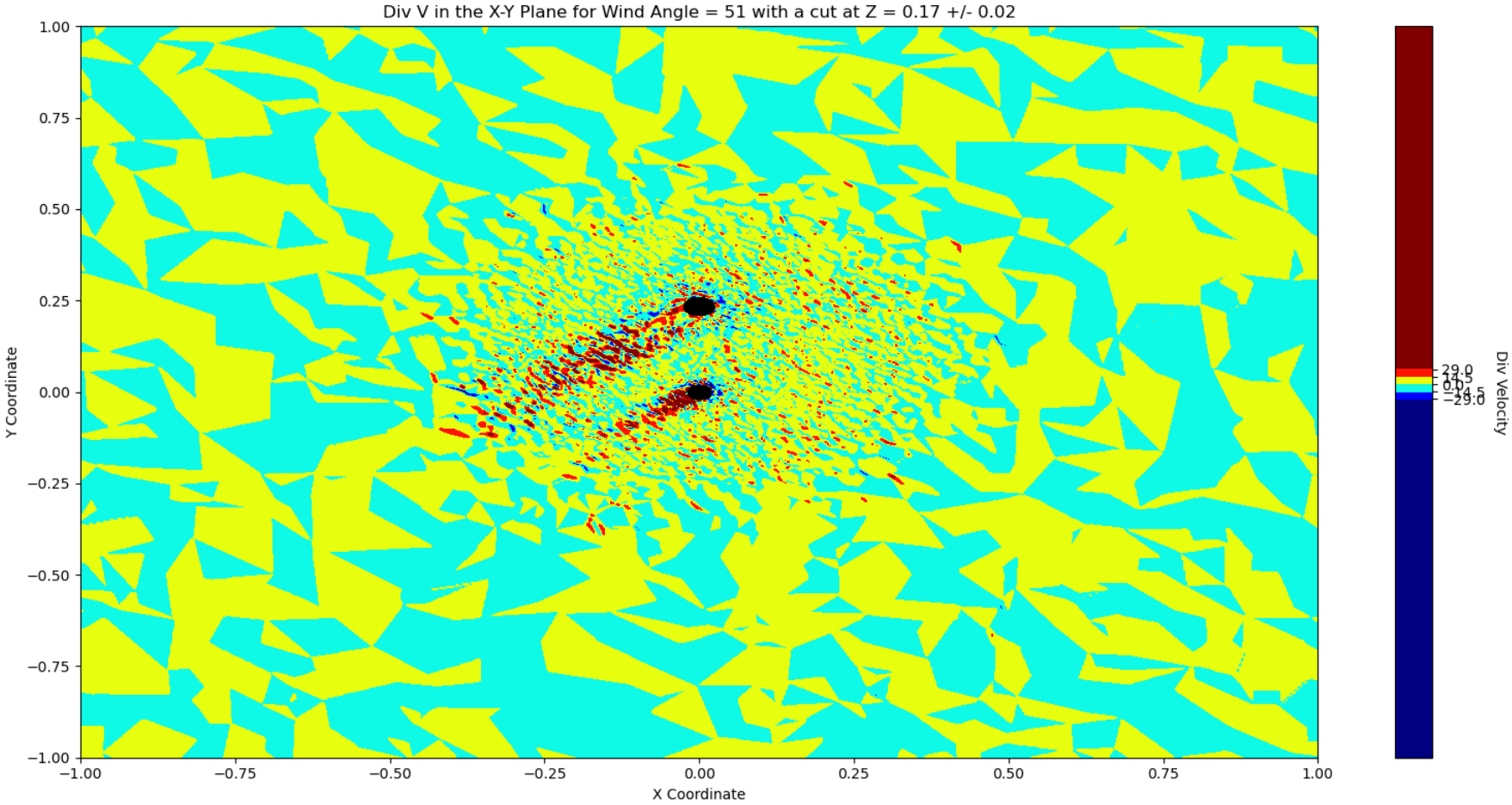

Div V in the X-Y Plane for Wind Angle = 46 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
31.0
15.5
0.0
−15.5
−31.0

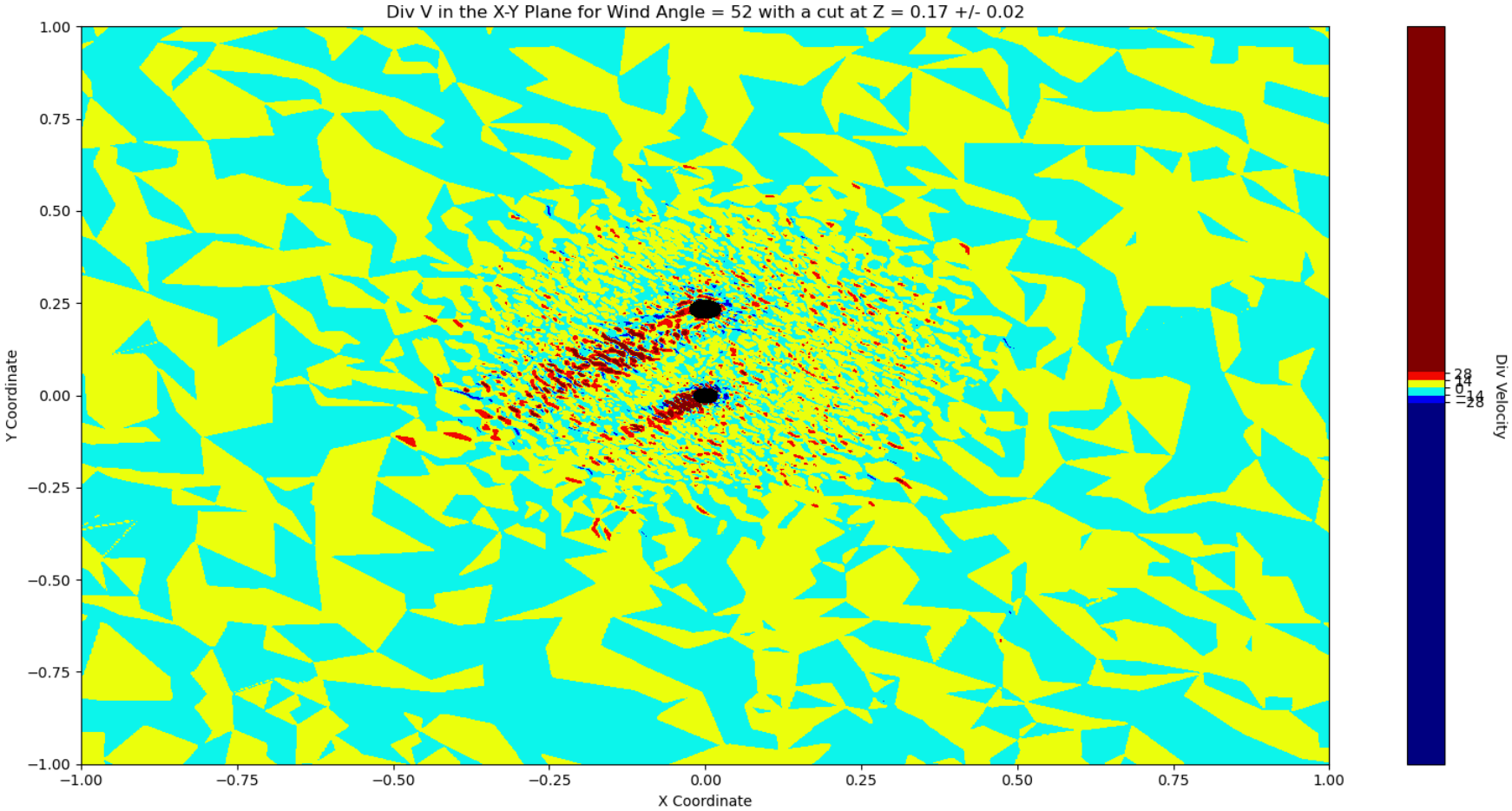

Div V in the X-Y Plane for Wind Angle = 47 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
31.0
15.5
0.0
−15.5
−31.0

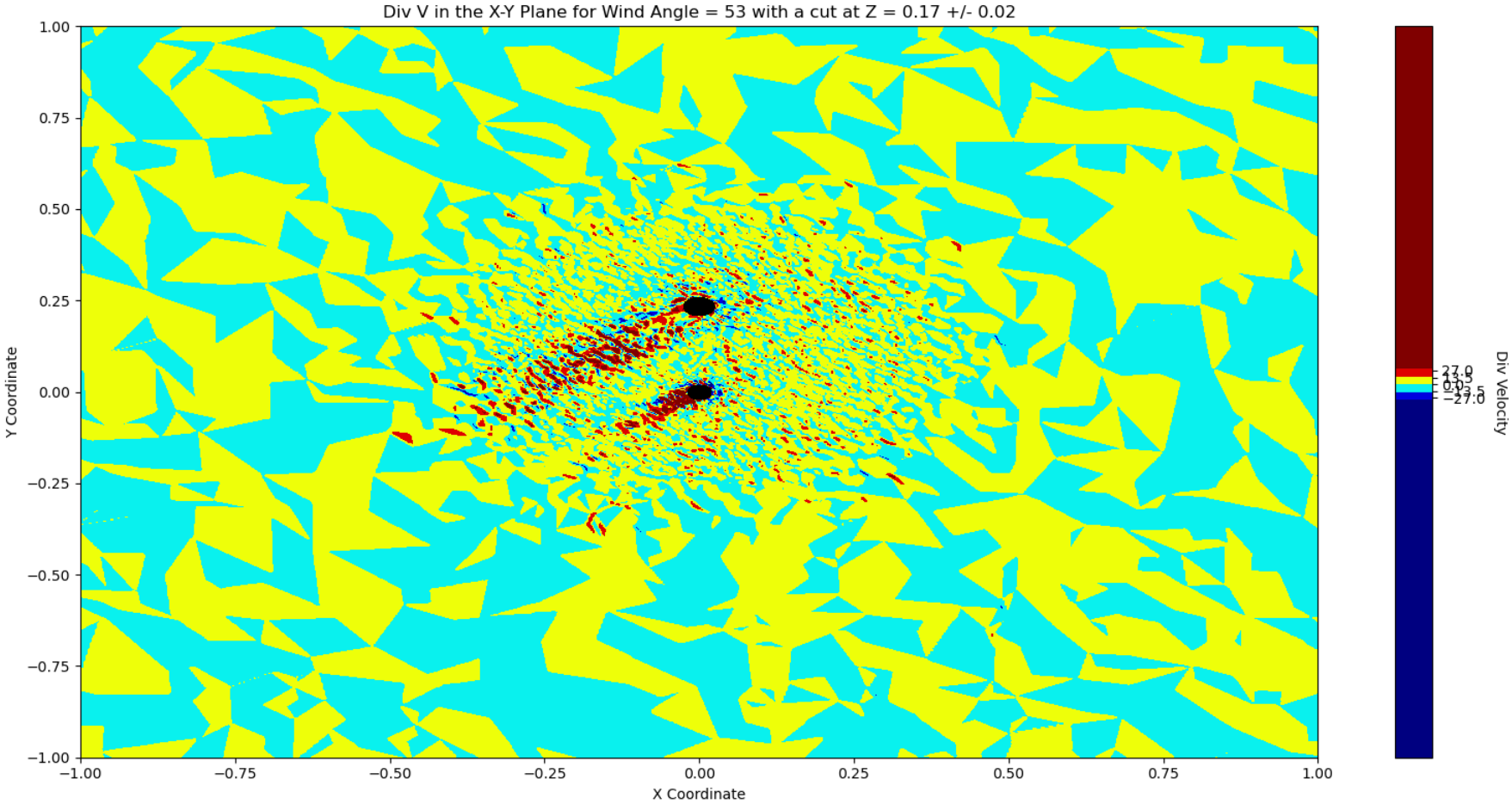

Div V in the X-Y Plane for Wind Angle = 48 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
31.0
15.5
0.0
−15.5
−31.0

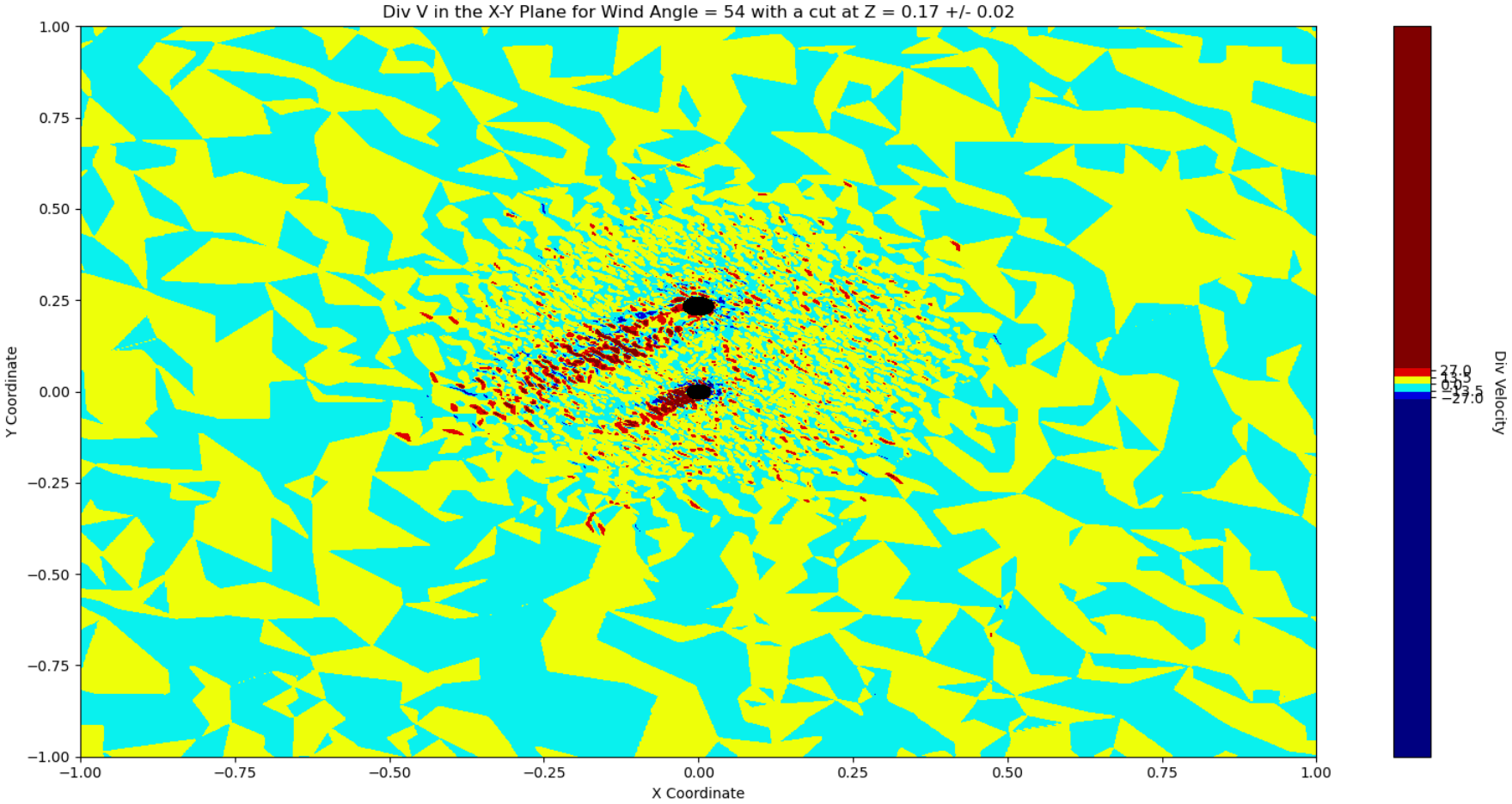

Div V in the X-Y Plane for Wind Angle = 49 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
30
15
0
−15
−30

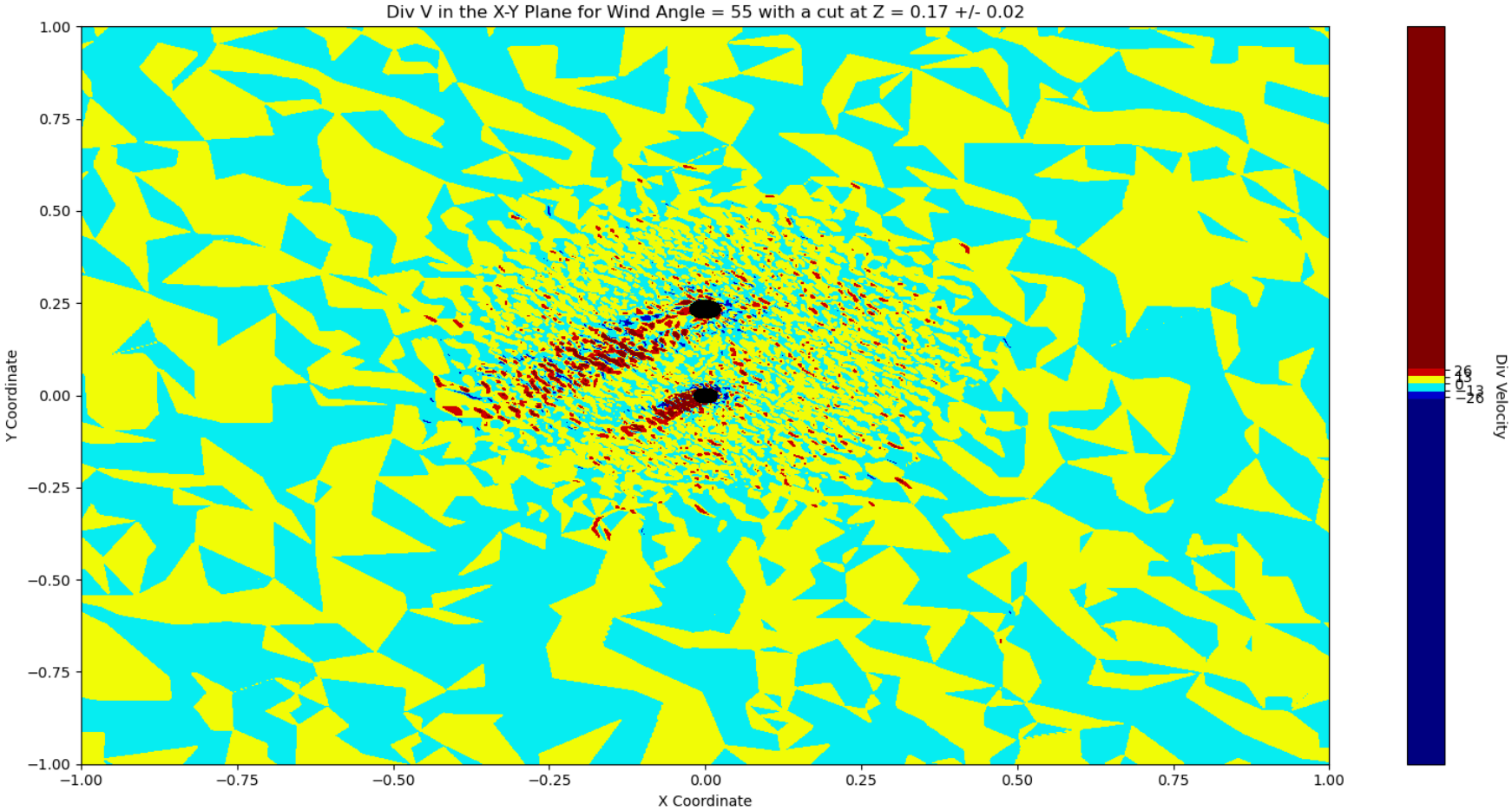

Div V in the X-Y Plane for Wind Angle = 50 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
30
15
−15
−30

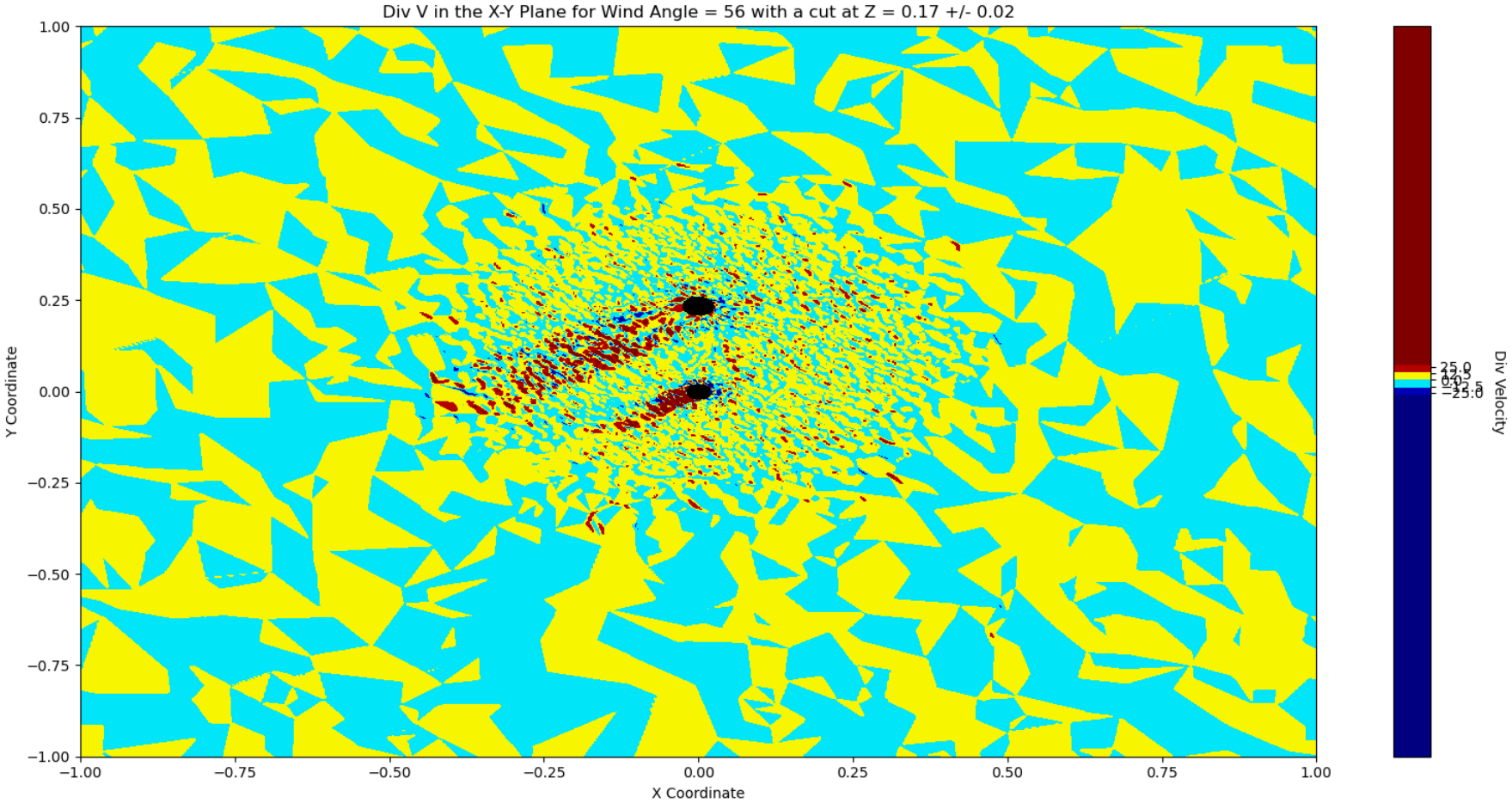

Div V in the X-Y Plane for Wind Angle = 51 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
29.0
14.5
0.0
−14.5
−29.0

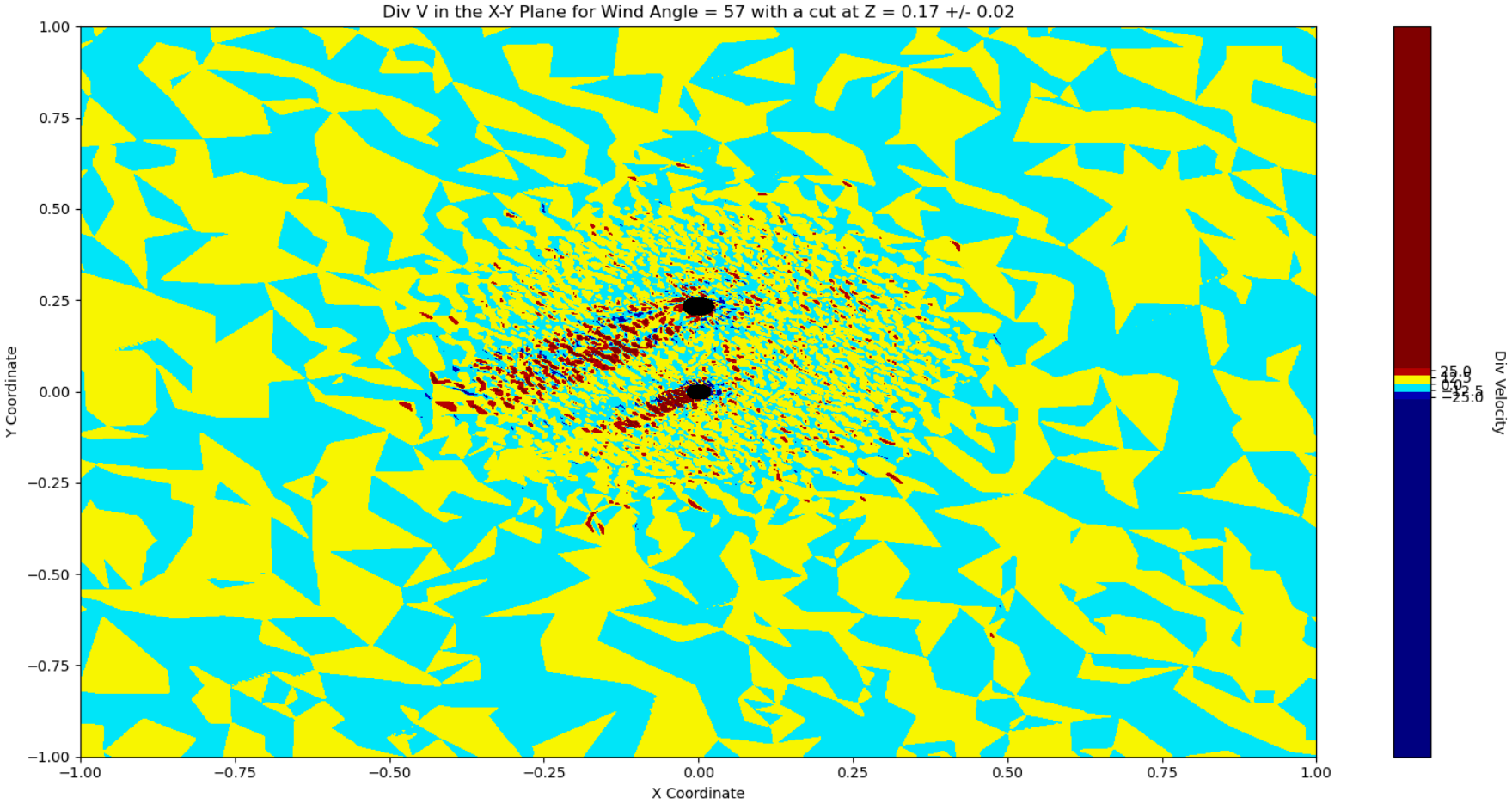

Div V in the X-Y Plane for Wind Angle = 52 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
28
14
0
−14
−28

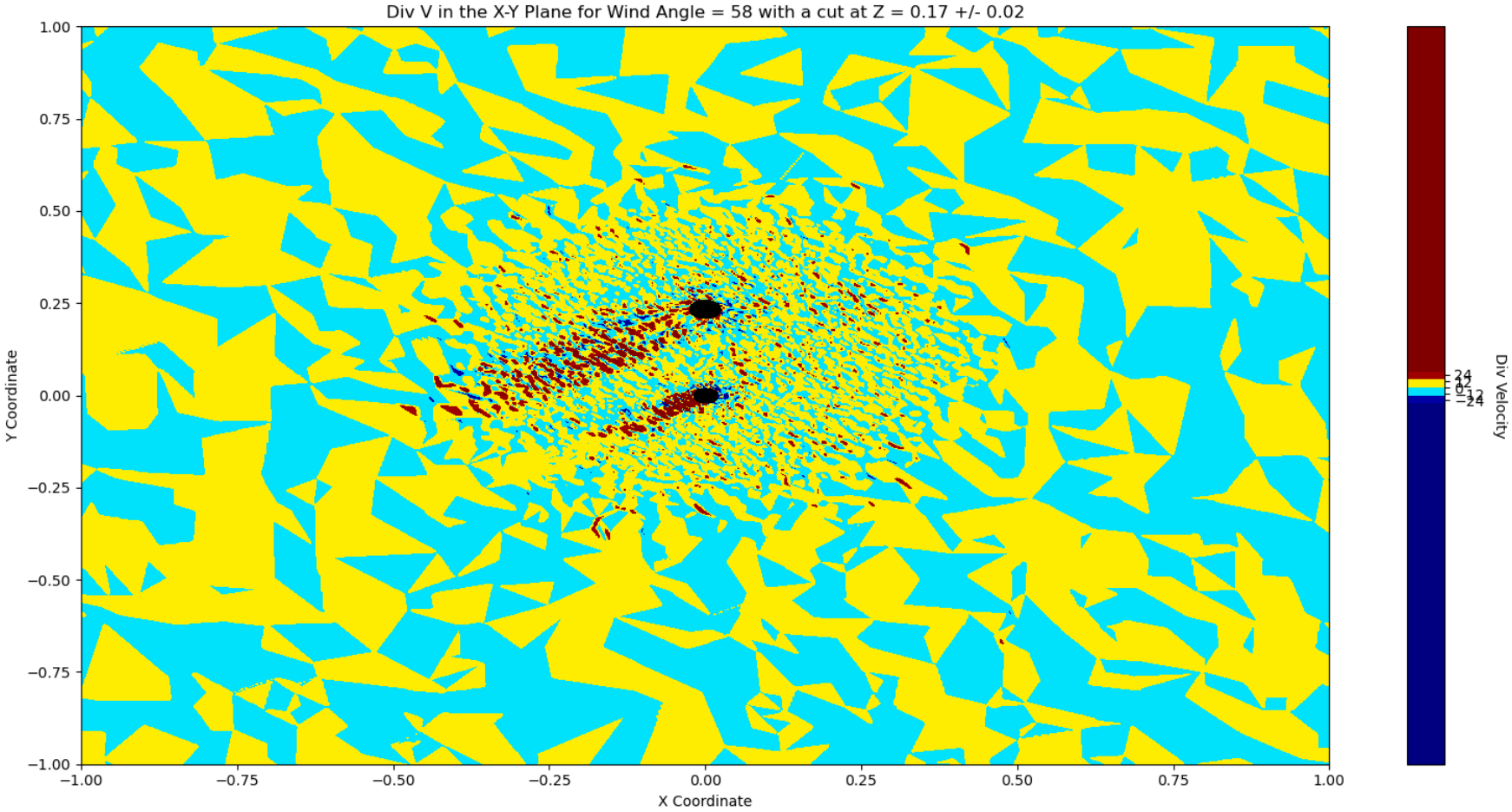

Div V in the X-Y Plane for Wind Angle = 53 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
27.0
13.5
0.0
−13.5
−27.0

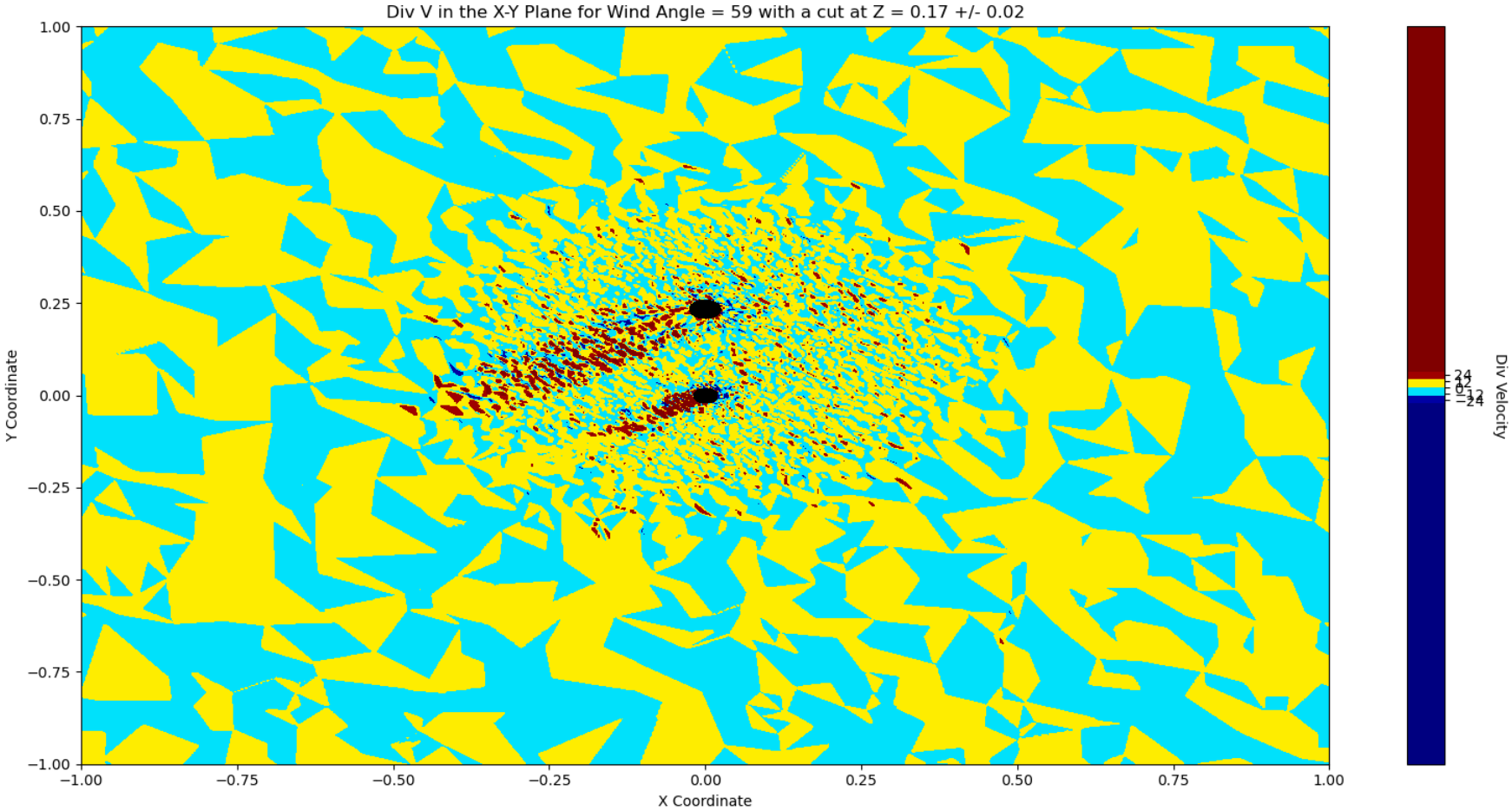

Div V in the X-Y Plane for Wind Angle = 54 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
27.0
13.5
0.0
−13.5
−27.0

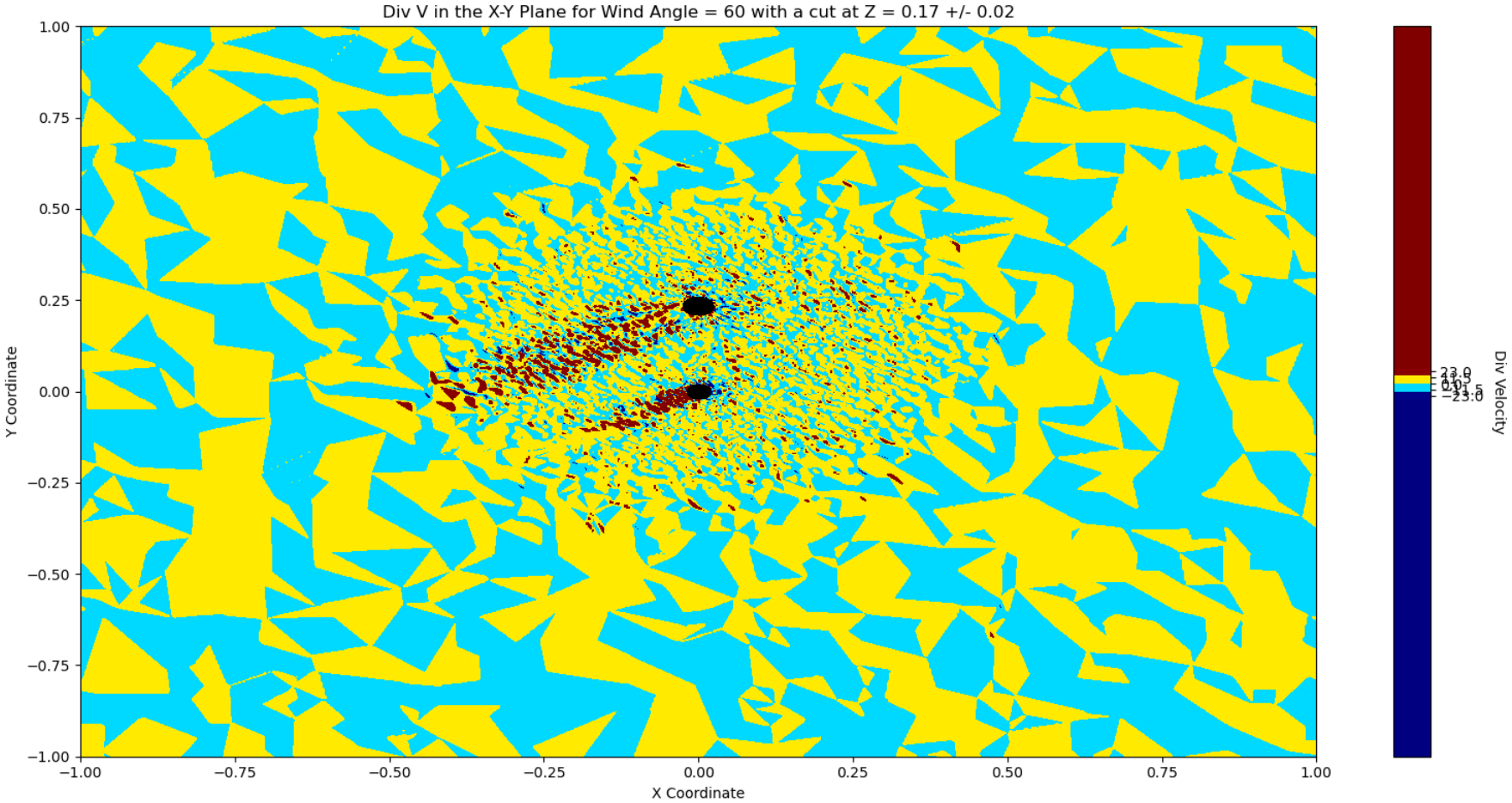

Div V in the X-Y Plane for Wind Angle = 55 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
26
13
−26

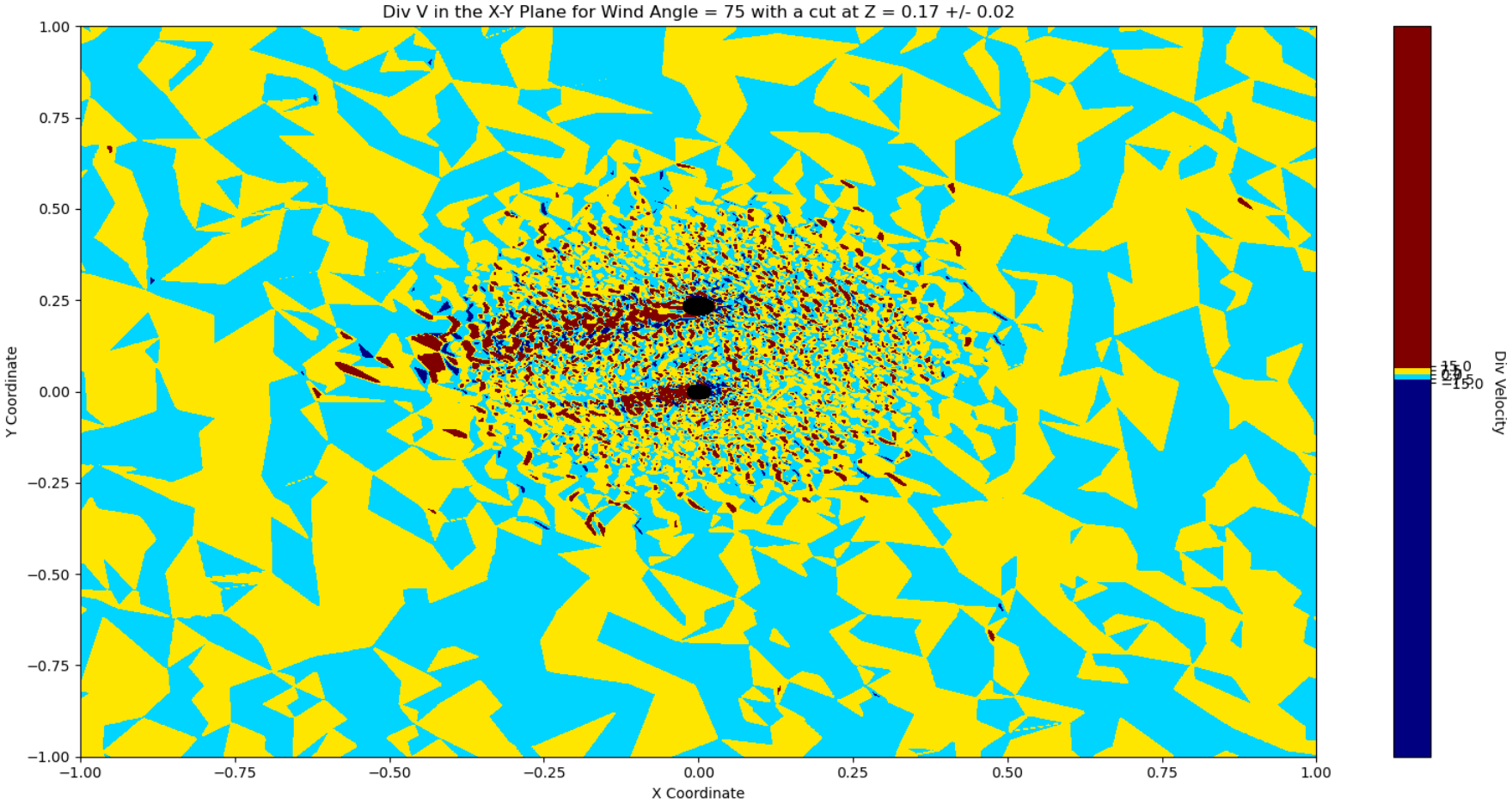

Div V in the X-Y Plane for Wind Angle = 56 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
25.0
12.5
0.0
−12.5
−25.0

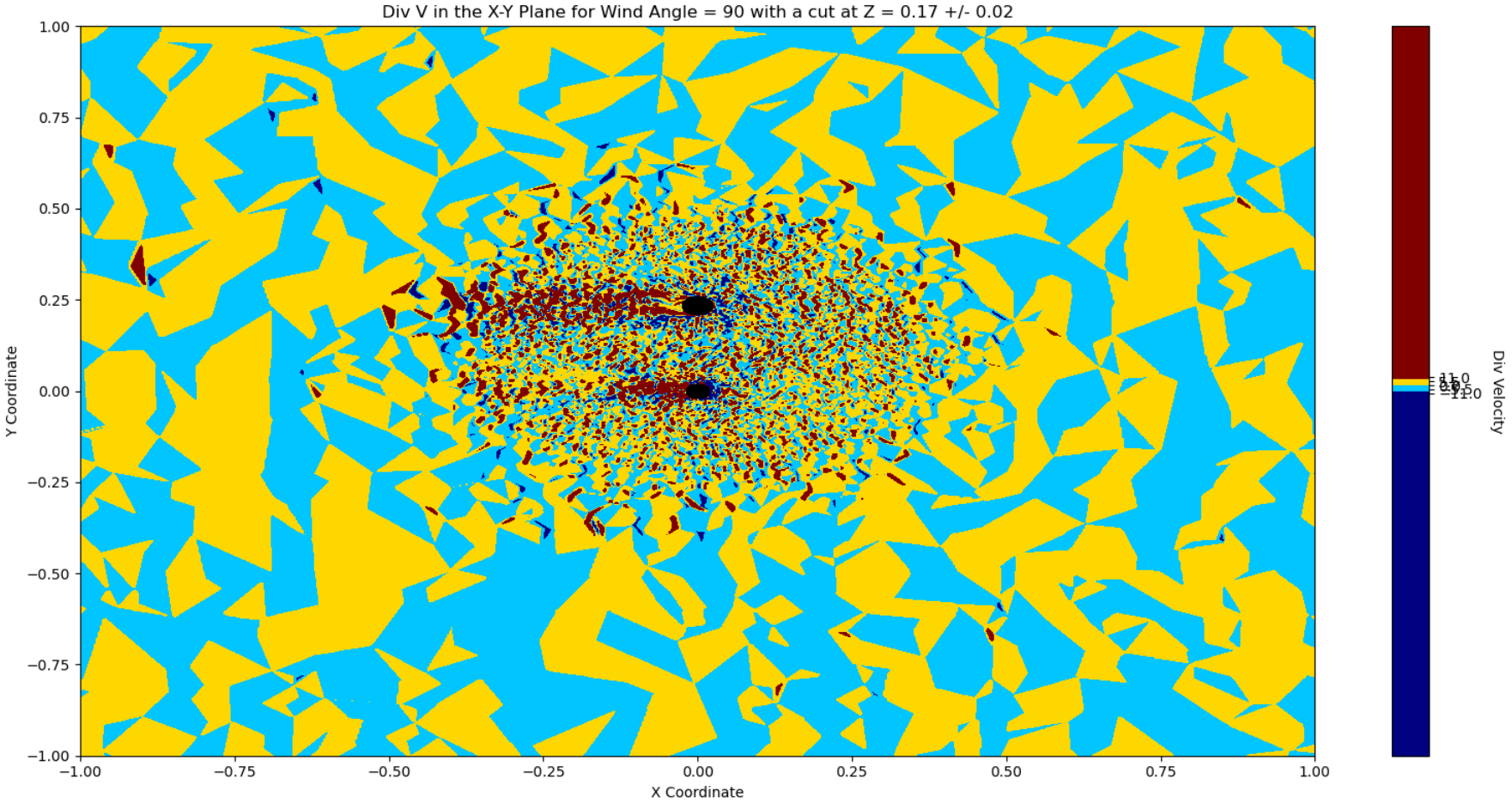

Div V in the X-Y Plane for Wind Angle = 57 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
25.0
−25.0

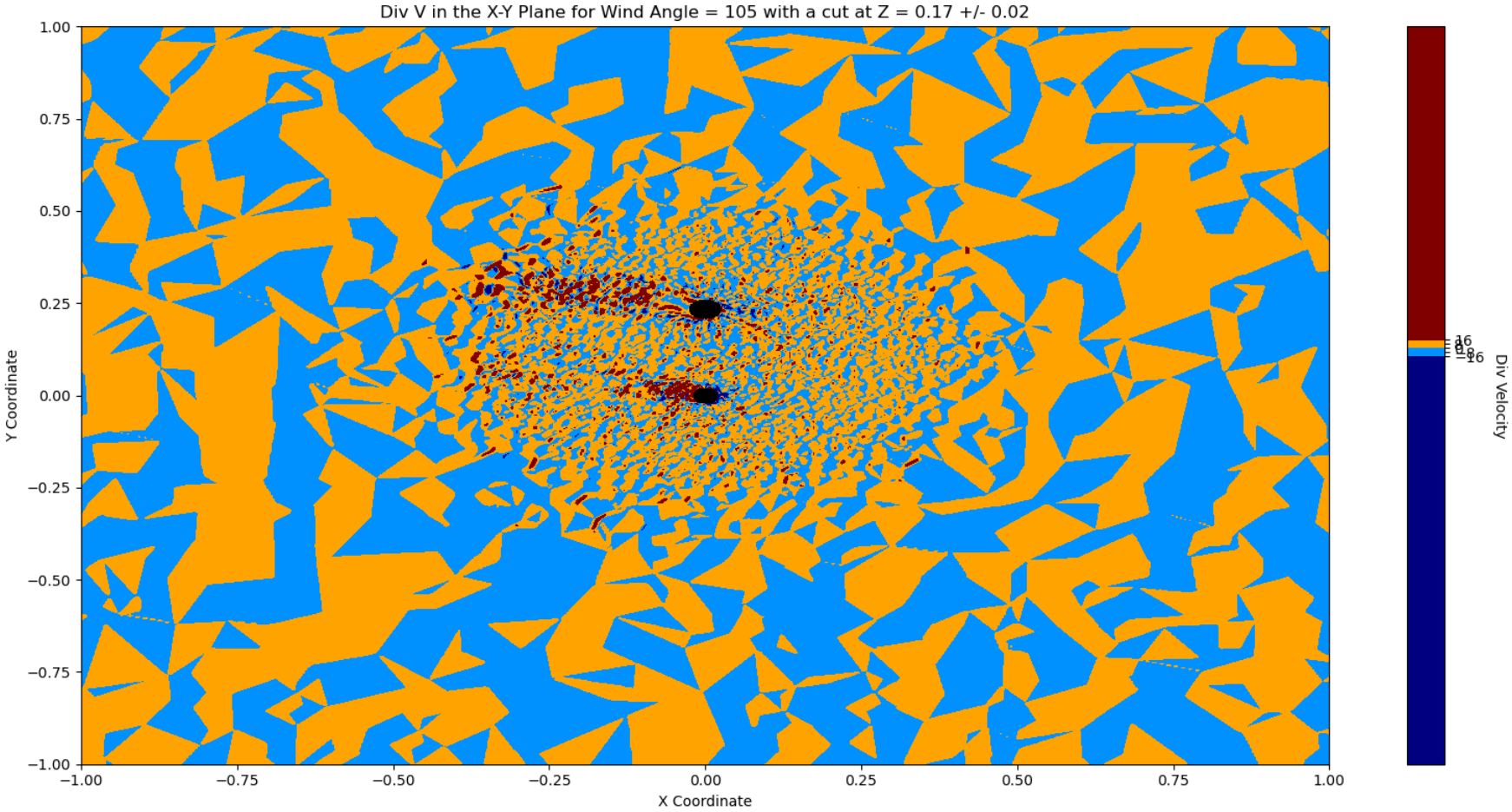

Div V in the X-Y Plane for Wind Angle = 58 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
24
12
0
−12
−24

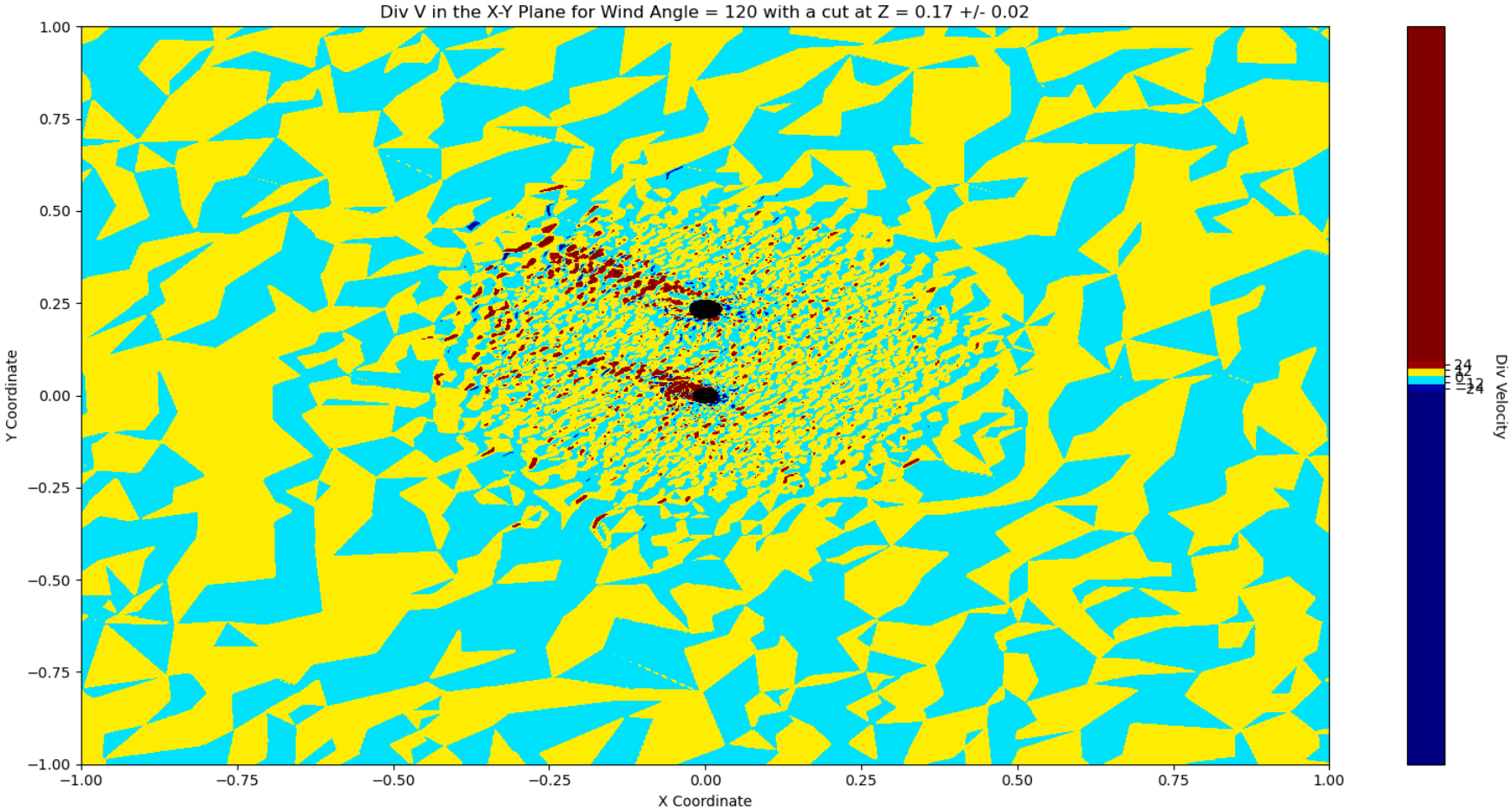

Div V in the X-Y Plane for Wind Angle = 59 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
24
12
0
−12
−24

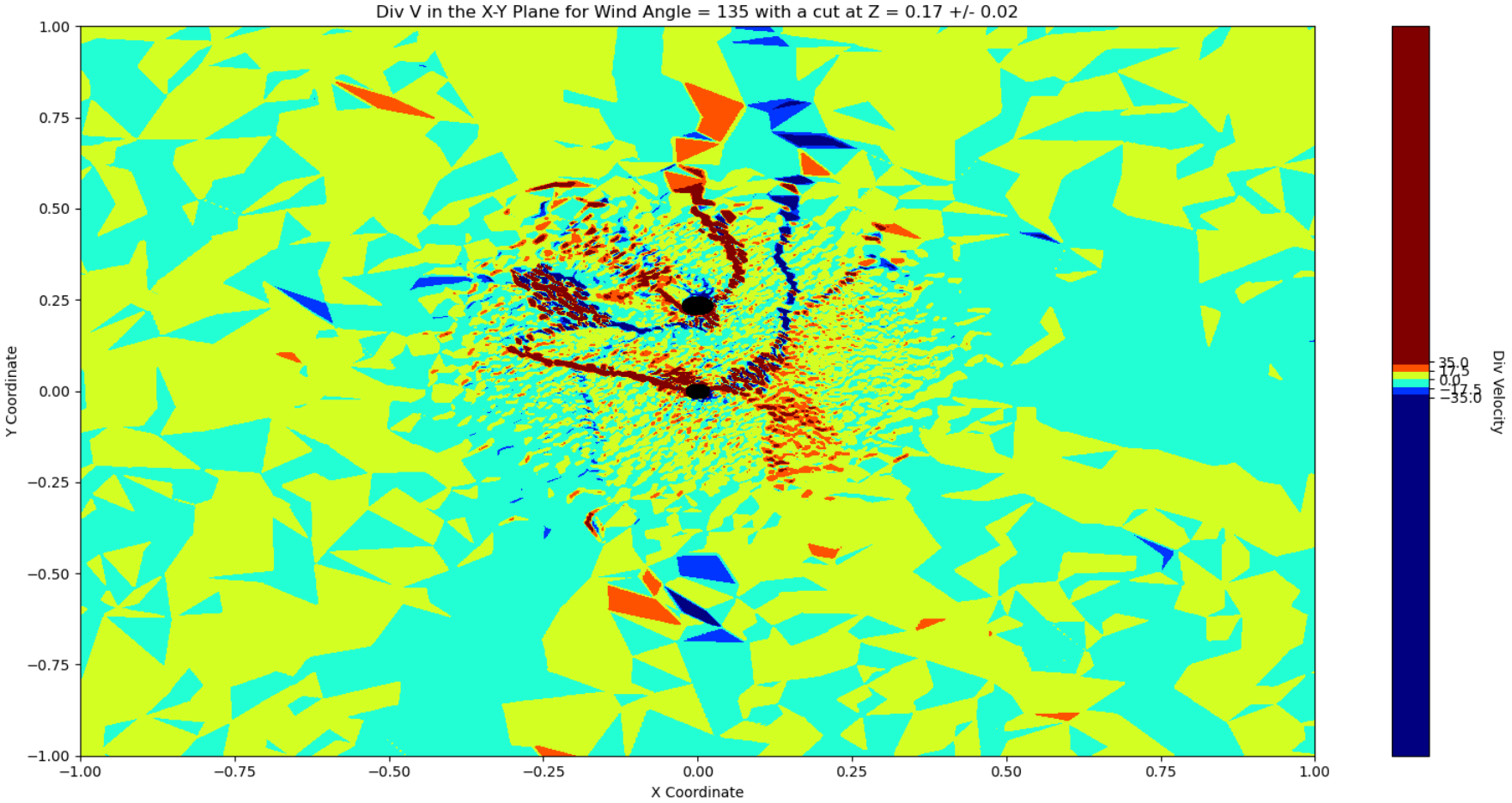

Div V in the X-Y Plane for Wind Angle = 60 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
23.0
−23.0

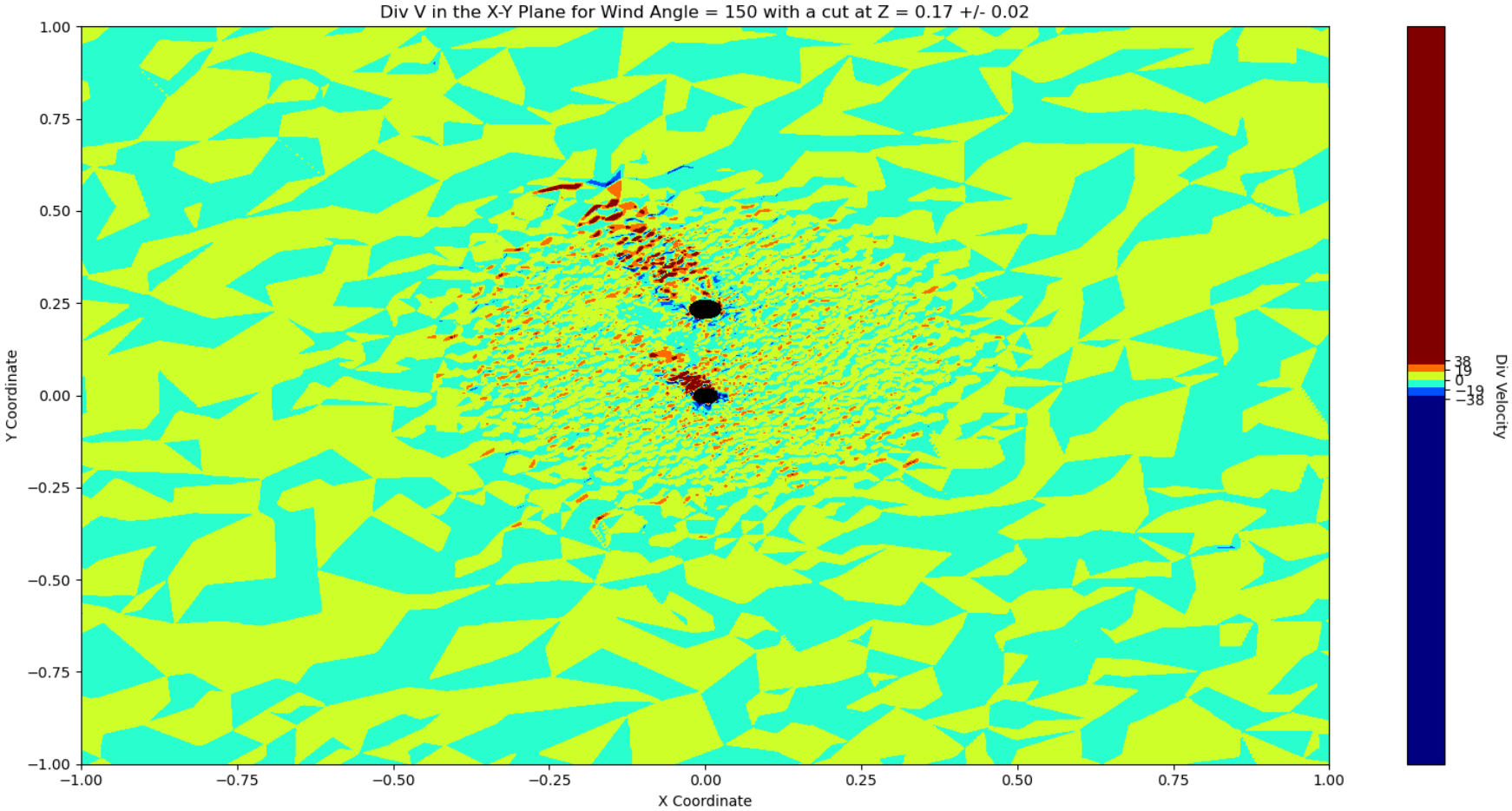

Div V in the X-Y Plane for Wind Angle = 75 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
15.0
0.5
−15.0

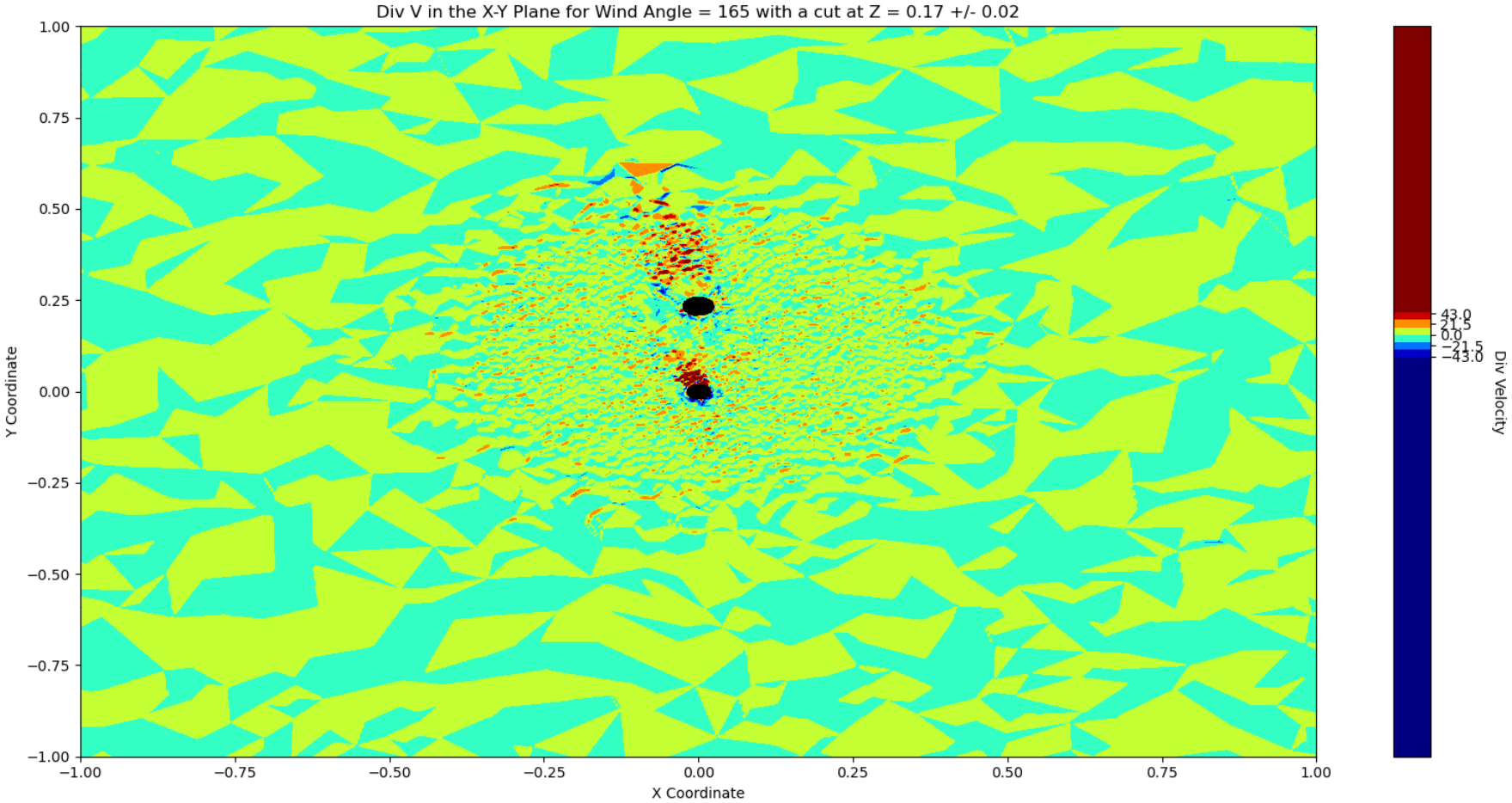

Div V in the X-Y Plane for Wind Angle = 90 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
1.0
0.5
0.0
−1.0

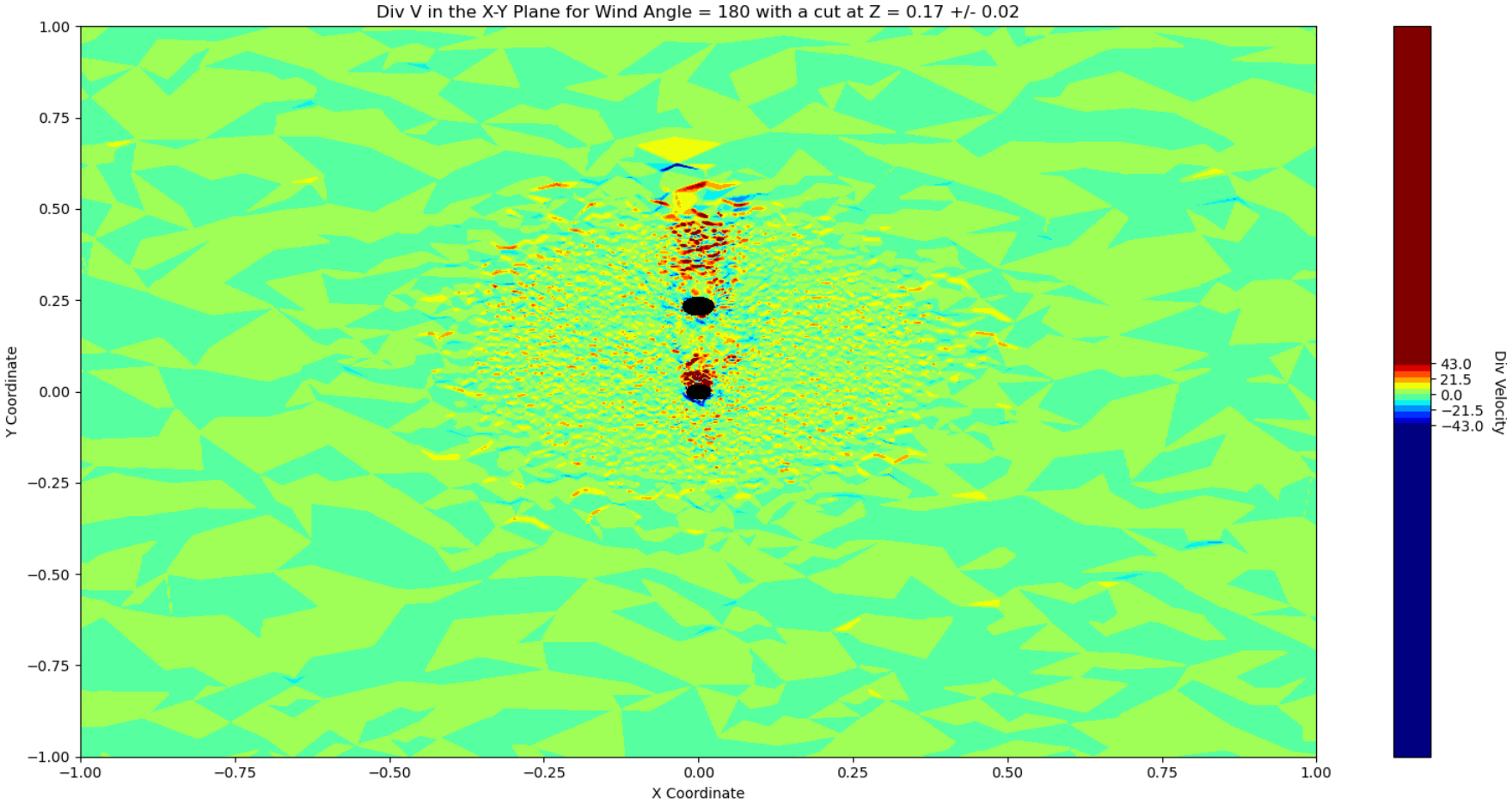

Div V in the X-Y Plane for Wind Angle = 105 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
Div Velocity


Div V in the X-Y Plane for Wind Angle = 120 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
Div Velocity
24
12
0
−12
−24


Div V in the X-Y Plane for Wind Angle = 135 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
35.0
17.5
0.0
−17.5
−35.0
Div Velocity


Div V in the X-Y Plane for Wind Angle = 150 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
Div Velocity
38
19
0
−19
−38


Div V in the X-Y Plane for Wind Angle = 165 with a cut at Z = 0.17 +/- 0.02
Y Coordinate
X Coordinate
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
43.0
21.5
0.0
−21.5
−43.0
Div Velocity


Div V in the X-Y Plane for Wind Angle = 180 with a cut at Z = 0.17 +/- 0.02
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
Y Coordinate
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
X Coordinate
43.0
21.5
0.0
−21.5
−43.0
Div Velocity

Some Next Steps

Explain why we seem to have issues with boundary conditions / physics

Convert scripts to Tensorflow